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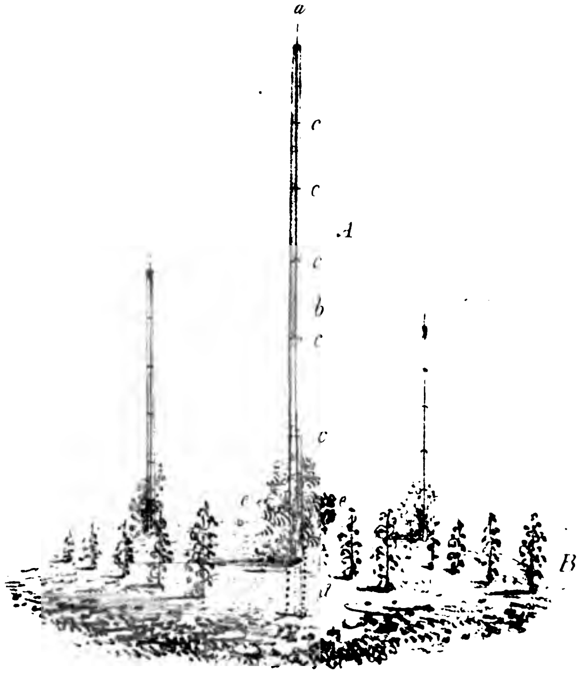
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A TREATISE

ON

ATMOSPHERICAL ELECTRICITY;

INCLUDING

LIGHTNING RODS,

AND

PARAGRÊLES.

BIBLIOTHECA · BODLEIANA

BY JOHN MURRAY,
F.S.A. F.L.S. F.H.S. F.G.S. &c. &c.

"THE HAIL SMOTE EVERY HERB OF THE FIELD, AND BRAKE EVERY TREE OF THE FIELD."—"THE THUNDERS AND HAIL CEASED, AND THE RAIN WAS NOT POURED ON THE EARTH."—*Exodus*, chap. ix.

LONDON:
WHITTAKER, TREACHER, & CO.,
AVE MARIA LANE;
AND DANIEL LIZARS, EDINBURGH.
MDCCCXXX.

192.

TO

RICHARD ELLISON, Esq.

SUDBROOKE HOLME,

LINCOLN;

THE AUTHOR,

IN RESPECTFUL ESTEEM,

INSCRIBES

THIS TREATISE ON

ATMOSPHERICAL ELECTRICITY.

ADVERTISEMENT.

THE following Treatise on the curious and interesting question of Atmospherical Electricity is introduced to public notice, with almost exclusive reference to *Lightning Rods*, as they are usually termed, and their congeners, *Paragrêles*, for the principle of both is the same. In order, however, to modify the question, and make it somewhat more general, a succinct view of Historical Electricity immediately follows the preliminary remarks, and in the sequel will be found the precautions necessary for personal security in the storm. A renewed interest has been excited by some recent remarks on Conducting Rods, on the part of Lieutenant Green, which we believe has even gone far to unsettle the faith of the British Government in their hitherto unsuspected efficacy; and it is presumed that though the phenomena of the Paragrêles may be a novel feature in the subject, in reference at least to this country, yet we feel confident in the successful results they promise,—far more efficient than Lightning Rods in local protection, they extend our views of their practical value much farther, and presage benefits which we had not contemplated as within the sphere of their influence.

1*st December*, 1829.

ATMOSPHERICAL ELECTRICITY,

&c.

CHAPTER I.

INTRODUCTION.

ATMOSPHERICAL Electricity embraces a wide field of inquiry, and involves not only questions of curious interest, but subjects of vast practical utility. If the recommendation relative to the general adoption of Paragrêles be followed up, it seems impossible to calculate the ultimate amount of good; nor does it seem to wear even the guise of being a problematical issue, but rather a conclusion naturally flowing from the inductive truths of electrical science, established on the known laws which regulate and controul its phœnomena. It seems indeed to bear the features of national importance, and even to recommend itself to the dispassionate consideration of the landed interest, nor can the wisest describe or estimate the final conquests and triumphs which the genius of science may atchieve, and, if a solitary metallic rod can command the heavens to yield their lightnings to its potent spell, what may not reasonably be expected from an immense army of marshalled points extending far and wide? In those parts of America where the thickets have been cleared, it lightens rarely, and the thunder's peal is never heard. When "the axe was laid to the root of the tree," the thunders were chased into the woods, and the lightning's flash serves now merely to illuminate the back ground of the forest's gloom: it is thus evident, that man possesses in the employment of judicious means, gleaned in the harvest field of science, a vast controul over the otherwise formidable obstacles of nature. By the drainage of the Pontine marshes, under the auspices of Napoleon Buonaparte, even the sallow and sickly hue of the visage, marred by the pestilential ravages of the Malaria, assumed the glow of health, and laid aside the vestment of disease; and in our own country intermittents once so rife, have scarce "a local habitation or a name." The field of electrical research is varied with many wonders, and is rich in interest; and though its phenomena are very subtile in their nature and relations, they are not on that account the less valuable and important. Electricity cannot, like many forms of matter, be weighed in the balance, or its amount computed by a scale of equivalents, neither can it be confined within the trammels of mathematical formularies, as it often bids defiance to philosophical rules, and overleaps their prescribed pale. These circumstances, conjoined with other causes, such as the protean forms of expression which it often assumes under the hand of the best experimentalists, seem in many cases to have wearied out its votaries; and this branch of science at the present moment boasts of few successful cultivators: notwithstanding all this, the importance of the subject is not lessened, nor its interest diminished. Lightning is identified with its playful diversities and beautiful forms, merely borrowed for a time from its aerial treasury—the theatre of its grandeur and majesty: the quantities we meddle with are indeed comparatively small, but it is lightning still, and those mimic fires that sparkle and explode may yet assume a loftier flight, become an integrant part of the forked terrors of the sky, and serve to swell the thunder's peal. Considerations such as these should kindle up an intensity of interest, awaken the powers of curiosity, and whet our intellect for the study of its mystic wonders;—is it not a sublime and imposing spectacle to stand by and contemplate science connecting as it were the heavens with the earth by a slender metallic rod, and presently witness the lightning descend upon its summit in all its terrible grandeur, and finally glide into the bosom of the earth in harmless corruscations? The rival scene may be sought for, but is no where to be found. When studying electricity, we are investigating the mightiest and most mysterious of nature's powers, interrogate its laws and agencies, and make lightning subservient to experiment by introducing such quantities only as can be safely managed in our scrutiny: for science can describe her magic circle round this formidable power, and within that barrier it may be handled and examined with impunity.

CHAPTER II.

HISTORICAL SKETCH.

The history of electricity is very instructive. The development of its curious facts and phenomena has not been the triumph of a day; on the contrary, their revelation rather, like the expansion of the flower, has been slow and gradual, the purchased reward of continued toil and active perseverance, while the picture of its history unveils the fact, that by far the greater proportion of the discovered phenomena is fairly ascribable to what we usually call accident, or such as we casually meet with or stumble upon in our search after truth, and comparatively little will be found to be the genuine offspring of the slow and sober calculating process of induction. Men are not fond of acknowledging the unwelcome position, but its truth is not unhinged by the reluctant confession: it will sometimes find an outlet in their own description of the case, or the manner in which they put the question. Now, as the circumference of human intellect can only enclose a limited number of the wonders embosomed in nature, an honest confession would appear the most creditable, as the former character wears a foreign and unnatural position, and one which circumstances are sure ultimately to betray. The great mass of discovery will be found, if weighed in the balance of truth, to be in a similar condition, and it reads to us the important lesson, that unwearied and assiduous perseverance in the field of experiment will certainly be rewarded by the crown and meed of unexpected and interesting facts. Electricity is an inexhausted mine of inquiry, and its votaries have yet much to learn and much to discover: the interest interwoven with the question is indeed great considered in its character as a science. It is the subtile and mystic agent to which meteorological phenomena are subordinated: it presides over the silent assimilations of vegetation, and extends even to the chemical processes and functions of animal being, under the controul and direction of the principle of life.

Thales of Miletus, who flourished about 600 years before our era, had discovered that *amber* when rubbed manifested the peculiar property of attracting light bodies when brought near it;—ηλεκτρον *(elektron)* is the Greek word signifying *amber*, and this is derived from the verb ηλκο *(elko) to draw:* hence amber possessing this peculiar manifestation is thus indicated, and those substances which acquire a similar property by friction, are in like manner called *electrics*, while the science which treats of their phenomena is appositely called ELECTRICITY. Theophrastus, of Eresus, records the same thing of *jet* and *agate*, while he includes the *lyncurium*, perhaps the *tourmaline* of modern mineralogy. These insulated facts, with the shocks of the torpedo, and the sparks elicited from the animal frame under peculiar circumstances, considered as so many separate phenomena, complete the summary of the wisdom of the ancients on this question. Their conclusions too, were always tinged with the colouring of the schools in which they were taught, and possess little weight or importance: in the Ionic school, for instance, motion was identified with mind, and it was therefore believed that the amber became animated by the mere circumstance of friction.* It thus appears that electrical science is the offspring of modern times, and its more imposing and important phenomena may date their rise and progress from the year 1600, when Dr. Gilbert, in his treatise on the Magnet, supplies us with a catalogue of various substances which become electric by friction. From this period the tide of discovery swells in magnitude, and accumulates in force in a regular and remarkable ratio, till it bursts upon us in the full blaze of Galvanism, and all its ramifications of electro-chemistry, electro-magnetism, thermo-electricity, and the magnetism of light—the effect doubtless of the electricity indigenous to light and colour. The list supplied by Gilbert was extended by the Honourable Mr. Boyle: the latter also discovered the electric light emitted from the diamond by friction, and found that light was also produced under similar circumstances by other electrics: Mr. Boyle, however, considered this light to be a distinct character of its agency.

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* The animated particles of Mr. Brown have no better foundation.

Dr. Wall appears also to have obtained electric light by rubbing amber on flannel, while Otto Guerike, the pro-consul of Magdeburgh, constructed an electric globe of sulphur, and obtained electricity from it by rubbing it with his hand, while it revolved on an axis. In a work, published by Mr. Hawksbee, in 1709, the electric property of rubbed glass is described, the light and noise that accompanied the exhibition, together with a variety of other phenomena connected with it, as those of attraction and repulsion: he appears also to have used in his experiments a revolving glass globe. Mr. Stephen Grey is characterized as a very assiduous experimentalist: he succeeded by means of a hempen string in conveying the electric matter from his balcony to an ivory ball suspended by it in the court below, but on subsequently attaching this hempen line by means of loops of pack thread, in order to transmit electricity in a horizontal direction, he could not succeed. Mr. Winckler, of Leipsic, and he then proposed that loops of silk should be substituted for the pack thread, which they concluded had from its greater size counteracted the effect: by using silk thread they succeeded completely, and it was ultimately discovered that the cause of their failure in the former case, and their success in the latter was not to be ascribed to the *size*, but to the peculiar *quality* of the material employed, and from this very simple accident arose the distinction between *conductors* and *non-conductors* of electricity. Mr. Grey also placed a wooden dish containing water on a cake of resin, and having communicated electricity to it, found that light and buoyant substances were alternately attracted and repelled from its surface—had the experiment been pushed a little farther, the discovery of accumulated electricity would have been complete—this, however, was reserved for another period of its history. Dessagulliers first proposed the distinctive and characteristic terms of *electrics* or *non-conductors*, and *non-electrics* or *conductors*—because the former by friction possessed the property of manifesting the phenomena of electricity but could not convey it away, while the latter though they could carry it off, were incapable of producing it by friction.* In the year 1732, Mons. du Faye found, during the repetition of Mr. Grey's experiments, that all bodies, whether solid or fluid, were susceptible of receiving electricity, on the approach of an excited glass tube, if such were placed on glass, or sealing-wax, provided the supports were perfectly dry. In his experiments, we find that *ice*, among other substances, was tried as an electric with success, and globes of ice may certainly be used as electrical machines, while pieces of ice, by mutual friction, will even evolve sufficient heat to liquify them: one experiment, among others, made by Du Faye merits particular mention: having suspended himself by silk cords, he was electrified in this condition, when the Abbé Nollet received from him the electric spark, the first ever drawn from the human frame. The merit of having first advanced the theory of the existance of *two* distinct and peculiar electricities belongs to Du Faye, and these were termed *vitreous*, and *resinous*, corresponding to the sources of production and obtainment, the vitreous electricity being the produce of the friction of *glass*, and the resinous that of *resin*, and other similar bodies. The announcement of the preceding facts led to more extended inquiries, and the number of its votaries proportionally increased.

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* This is merely a *general* position, since copper filings sifted through a sieve of zinc, and, *vice versa*, affect the electroscope.

About the year 1742, M. Boze, of Germany, re-introduced the globe employed by Hawksbee, as a substitute for the tube, which appears after that period to have been exclusively used in experiments: he also suspended an iron cylinder, by means of silk cords, to serve as a conductor to the globe, while a fringe of threads, attached to one end of it, served to collect the electricity excited by the revolution of the globe. Mr. Winckler applied a cushion to the globe, the hand having been previously employed in all experiments; the human frame, in contact with the earth, its fruitful source of supply, being the medium of communication. For the cylindrical form of the electrical machine we are indebted to Mr. Gordon, and though not immediately connected with this part of its history, it may be added, that the *plate* electrical machine was introduced by Dr. Ingenhouz.

With this improved and powerful artillery of apparatus, the field of experiment became brighter and more enlivened. Dr. Watson exhibited a great variety of experiments, new and curious at that period, such as the inflammation of spirits of wine, and other combustible substances: he excited no less than four glass globes at once, and, agreeable to his own description, the electricity was so intense and brilliant, that when "two pewter plates were held, one in the hand of an electrified person, and the other in the hand of one who stood on the floor, the flashes of pure and bright flame were so large, and succeeded each other so fast, that, when the room was darkened, he could distinctly see the faces of thirteen persons, who stood round the room." The year 1746 stands a bright point in the annals of our science, since it was crowned with the beautiful discovery of accumulated electricity, by means of which a vast accession of power was gained, increasing with the multiplication of the apparatus and extension of the surface. It has been stated, that to Mr. Von Kleist is due the germ of the discovery we are about to communicate, who employed a phial, having a blunt piece of wire loosely inserted into it. Be this as it may, Professor Muschembroeck associated with Messrs. Cuneus, Allemand, and Winckler, were making experiments with water, in glass bottles or jars, but, whether with reference to the experiment attributed to Von Kleist, or founded on a supposition that a modification of Mr. Grey's experiment, might concentrate the spark taken from the conductor, does not clearly appear. The mere insertion of a wire into a glass bottle, without water, or a metallic coating, as appears to have been the case in Von Kleist's experiment, would not have accumulated the electric matter in quantity sufficient to communicate a shock: had the wire, indeed, rested in the phial in a compressed spiral form, and the hand covered the exterior surface, this effect would have been partially attained. During the interesting experiments, made by Mussembroeck, and his coadjutors, Cuneus, of Leyden, was accidentally holding with one hand the glass bottle, containing water, which had been suspended to the conductor of the electrical machine, while the other was about to untie the wire of attachment, when he experienced that new and nondescript sensation, called the *electric shock*, as the consequence of introducing the animal frame into the circuit formed by conjoining the external and internal surfaces of a glass jar, supplied with an accumulation of electricity. The vessel thus employed is called the *Leyden Jar*, from the birth place of its discovery, and that of its discoverer, M. Cuneus, of Leyden.

In consulting the historical records of this science, we find various exaggerated and romantic accounts of the effects of the electric shock, on the several individuals who had the courage to try it. Though it is readily granted, that, in the infancy of so extraordinary a discovery, the timid mind might be severely wrought upon, and its fears and alarms be the fruitful parent of not only imaginary evils, but of physical injury, subordinated as is the corporeal system to the fever of the mind; yet, much that is recorded must certainly be received "cum grano salis." Professor Winckler, having received the shock, informs us, that it occasioned severe convulsions, so that he was afraid of an ardent fever, and was necessitated to employ refrigerating medicines: he also bled at the nose: notwithstanding all this, Madame Winckler would hazard the dread experiment, the consequence of which was, that she could hardly walk afterwards, and in complimental sympathy to her husband, also bled at the nose. Muschembroeck received the shock from a thin glass bowl, and declared that he would not take another for the entire kingdom of France; the Professor, however, appears to have been more frightened than hurt. Boze, to whom we have already alluded, on the other hand, expressed a wish to *die* by the electric shock, that his name might live immortalized in the annals of the French Academy of sciences: this was pitiful bravado, though Dr. Priestley thinks otherwise, and is pleased to call it "a truly philosophical heroism, worthy of the renowned Empedocles," whose slipper was found indigestible by the cyclops of Etna, and ejected as a receipt for the body of the suicide: Muschembroeck's timidity is certainly amusing enough, and Boze's affected courage truly *French.* No doubt the power of the electric shock on a feeble frame, or in some idiosyncrasy of its constitution, might be exceedingly injurious, and leave a permanent record of its power; and a good deal, too, will depend on the way and manner in which it is given, together with the nature of that part of the animal frame submitted to its influence. Mr. Singer informs us, that he once accidentally received a considerable charge from a battery through the head; the sensation, he adds, was that of a violent but universal blow, followed by a transient loss of memory, and indistinctness of vision; and Mr. Morgan, in his published "Lectures," says, that if the *diaphragm* be made part of the circuit of a charge equal to two feet surface, the lungs make a violent effort, followed by a loud shout, but if the charge be small, it never fails to produce a violent fit of laughter, and the *comic* powers of electricity are quite irresistible: on the other hand, a strong charge on the *septum* is not unfrequently followed by some of the features of tragedy, as sighs and tears, and even syncope.* About the year 1747, Dr. Bevis coated a pane of glass on both sides, with tinfoil, the principle of that called the "magic picture," and occasionally used to surprise by the shock it communicates. Subsequent to this period, Dr. Watson coated large glass jars, with silver leaf, and the accumulated intensity was by these means so much increased, that wire was melted, and birds and fishes killed by the electric discharge. The French philosophers made many interesting experiments on a large scale: the shock was, in one instance, passed through a wire, extending about two and a half English miles, and it was discovered, that, as soon as the electricity was withdrawn from the end of a wire 1319 feet long, it ceased simultaneously at the other. The Abbé Nollet, in the presence of the King of France, gave the electric shock to 180 of the French guards at the same time, and in another instance the shock was passed through a line of Carthusian monks above a mile long, who were separated the one from the other, by iron wires. On the 14th of August, 1747, Dr. Watson made an experiment on Shooter's Hill, in which it was proved, that the electric matter occupied no sensible portion of time in traversing an extent of four English miles. The observers were supplied with accurate stop watches, to note the instant they felt the shock, but the result proved that it was contemporaneous with the discharge.* This rapid movement of the electric power had suggested its application to the purpose of a telegraph, we believe, by Mr. Ronalds, but recent experiments, made with reference to this question by Professor Barlow have rendered it altogether equivocal. To those duly acquainted with the phenomena of electricity many counteracting agencies may be naturally expected to disturb the equable and full transmission of the electric discharge, but it occurs to the writer, that if a copper wire (next to silver, the best conductor,) included in another as its shell or cearment, and this external hollow wire were coated with shell lac (the best insulator) the charge might be without difficulty conveyed with electric rapidity, to a far distant point, and thus become the prompt medium of intelligence, the number of consecutive discharges might be read off as the cypher of the telegraph, and the ends of the wires, namely, the transmitting and return wires, at the extremity of the distance, might pass through glass tubes filled with water, which would concentrate the intensity of electricity, and thus be applied even to kindle gunpowder, and by successive explosions announce the intelligence. The electrical machine at the other end of the circuit would require to be simply turned by the winch, or put in motion by machinery, the Leyden jar being in close contact with the conductor, the upright insulated and self-acting electrometer attached to the plate machine would, at regular intervals, effect the discharge. Electricity might be also elegantly employed to light the gas jets used for street illumination—a common stop-cock might allow the gas to flow simultaneously at each orifice, and by one electric discharge, the several jets on the principle of Volta's inflammable air lamp would be instantly kindled, and the entire metropolis of London be illuminated with the rapidity of a flash of lightning.

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* Though we are no friends to the fooleries of animal magnetism, or the knavish tricks of mesmerism, it is a fact worthy of note, that, unless the medical electrician is sufficiently guarded, a *partial transfer of the malady of the patient may be made to him*, and this we have been *assured has actually been the case*, more than once, in the practice of a medical electrician.

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* This is not exactly the case.

By the most accurate analogical reasoning, Dr. Franklin inferred the identity of lightning and electricity, the only inductive point that we can perceive in the whole history of the science: this opinion was known to the world as well as the sound principle of reasoning on which that opinion was formed. The conjecture appears to have been verified in France, on the 10th of May, 1752, by Dalibard, Le Lor, Mazeas, Buffon, and Monnier: a bar of iron forty feet high, situated in a garden at Marly, was electrified by the transit of a stormy cloud over it, by which phials were charged and other electrical phœnomena exhibited. It was reserved, however, for Dr. Franklin to verify, altogether independent of this event, his own rich and inductive conclusions;—believing that the cloud would consign its lightning to pointed conductors, he had already waited a considerable time for the erection of a spire in Philadelphia; in the meantime, however, it occurred to him that a common kite might afford a ready medium of access to the region of the storm. In June, 1752, a kite, with a pointed wire attached to its summit, was launched into the air, the kite was fastened to a key, by means of a hempen string, and the key attached to the earth by a cord of silk, concluding that this arrangement would facilitate its accumulation on the key, being insulated by the silken cord. According to the account which he has given us of the experiment, a considerable time had elapsed before the string of the kite afforded any signs of its having been electrified, and a promising cloud had already passed over it; his hopes had indeed begun to flag, when he observed some loose threads to stand erect, and be mutually repellent: on this indication he presented his knuckle to the key, and the splendid discovery stood complete in all its form and character, and as soon as the string was moistened by the rain which fell, the sparks were copious: phials were charged at the key, and many of the experiments usually performed by the electrical machine were repeated here. At the moment the electric spark glanced from the key, it is stated, the Doctor heaved a sigh; his feelings may be faintly conceived, but to describe them were impossible: language is inadequate to pourtray the agitation of the mind, when *eureka* vibrates on the lip of the discoverer, and that discovery is fraught with some important relation to the economy of life; the great practical value here consisted in the attachment of lightning-rods to buildings, to shield them from the stormy elements. By means of a pointed conductor the Doctor introduced the lightning into his dwelling, and a peal rung by it on two bells announced to our Philosopher the apparatus charged by meteoric fire; —Dr. Franklin's daring experiment has no counterpart, save in the fire which Prometheus caught from the heavens on Elborus amid the snowy range of the Caucasus.—" Eripuit cælo fulmen."

Mon. De Romas entwined a wire with the string of the kite he employed, and its size was seven and half feet long, and three feet wide; this wire renders the string a complete conductor, and fine softened copper wire serves very well. During dry weather I have always obtained, in any season, or at any period of the day, as much electricity as I could safely manage, and ever preferred for the scene of experiment, an elevated situation in the open country. It is dangerous to raise an electric kite during a thunder storm, and sufficient electricity can, under ordinary circumstances, be obtained from the atmosphere, without incurring such fatal hazard. On the 7th June, 1753, about one o'clock, P.M., when the elevation of the kite was 550 feet, and it had taken 780 feet of string, subtending an angle, with the horizon of about 45°, M. de Romas drew sparks from the conductor of the apparatus, a quarter of an inch thick, and three inches long, and the snapping was audible at 200 paces distant:

on the 16th August, 1756, the streams of electric fire were truly imposing, being apparently one inch thick, and ten feet long, the report was equal to that of a pistol, and yet it was safely conducted by the string of the kite to the earth, by a conductor placed in its vicinity: experiments of this formidable description, however, are far too dangerous for repetition.—To sum up all, we perceive that the chief epochas in its history, are, I. Discovery of the agent itself: II. The phœnomena of attraction, &c. III. Distinction of *electrics* and *non-electrics*: IV. Accumulation of electricity: V. Identity of lightning and electricity; and VI. Practical application of conducting rods.

CHAP. III.

METEOROLOGICAL PHENOMENA SUBORDINATED TO AND DEPENDENT ON ATMOSPHERIC ELECTRICITY.—DIFFERENT ELECTRIC STATES OF THE ATMOSPHERE—AERIAL ELECTROSCOPES.

We properly consider that the whole host of meteorological phœnomena is connected with electrical principles or modified by them.—The dew that bathes the verdant carpet of the ground, and flickers in rainbow imagery in the morning beam,—the modification of the cloud from the *cirrus* to the *nimbus* and that nimbus charged with lightning and tempest—deluging the plain or pelting the earth with hailstones or fragments of ice; together with the meteors that flit and reel through the heavens; or traverse their surface in luminous lines, or curtained in the sky fan the air with films of diluted light—including those very singular atmospheric precipitations called aerolites, —all are either the creation of electricity or electricity itself.—The experiments of Signor Beccaria, continued with persevering assiduity for fifteen years, lead us to conclude that the air is almost constantly electric, that this electricity is usually positive, and relates to the amount of vapour it contains, while it is probable, according to Mr. Daniel, that the elasticity of vapour is increased when electrified.—The passage of clouds over the electroscope frequently affect it, together with a current of air from the spot where clouds are forming or rain falling: with the exception of these, it should seem, that negative electricity is rarely observed, and these may be called occasional or accidental circumstances: in cloudy weather weak positive electricity obtains, which changes to negative on the fall of rain, and when the rain ceases it returns to its primitive positive state.—Positive electricity is weakest in the atmosphere during summer, and has its greatest intensity during winter: the usual positive electricity is weakest during night, increases with sunrise, decreases towards the middle of the day, again increases as the sun declines, diminishes again, and during the night remains weak; all these facts seem to prove that the electricity of the atmosphere is influenced by the same causes which promote the equable distribution of moisture. It has been stated, that in clear weather the electricity is found in a positive character, but this is disturbed by currents of air or the approach of clouds, especially when they hover near the apparatus, and this has been particularly noticed in the vicinity of the Appenines, or other mountain ranges. In the precipitations of rain, hail, &c. the air will be found always negative, and the oscillations from positive to negative and *vice versa* during a thunder storm, will be found exceedingly rapid: the question connected with the electric character of the atmosphere is one of intense interest: we are inclined to suspect that it is in the electric state of the air, as affected by moisture, in relation to the animal frame, that will be found the true solution of the effects of *malaria*, modified; doubtless, by the morbid effluvia which exhale from stagnant marshes, &c. holding in solution decomposing animal and vegetable matter; while the lines of demarcation in typhus and intermittent fevers may have, often altogether independent of a local humidity, an electric relation to the rocky substrata of the spot itself.

We have not made electric experiments in fenny countries during autumn, but at Orbitello and in the Pontine marshes in Italy, our electroscope showed that the prevalent electricity was of a negative character, and it is worthy of particular observation, that the air of rooms vitiated by respiration is constantly imbued with negative electricity. Should a series of experiments, made with great care, and prosecuted with perseverance, prove that the electricity of the atmosphere is immediately connected with the morbid change of those peculiarly gifted localities, some modification of the paragrêle hereafter described, may operate a beneficial change.

Aerial *electroscopes* are instruments for determining the kind and quantity of atmospheric electricity; they differ from other electrometers (for the principle is the same) only in possessing caps to preserve the insulation more completely, and having pointed rods attached to their summits;—of these there are several varieties, as Volta's, de Luc's, Ronalds', Kinnersley's, and others: that which Mr. Ronalds employed to ascertain the kind of electricity on Mount Vesuvius was supplied with a pair of straws, in Volta's manner, instead of pith balls, or slips of gold leaf, and it had a rod fourteen feet high. Mr. Kinnersley's electroscope consists of a hemispherical glass cap of about two inches in diameter—narrow slips of tinfoil are attached on opposite surfaces, within the instrument, and from the top, two minute pith balls are suspended by linen threads, the balls being parallel with the slips of tinfoil, a brass dome elevated about half an inch from the stem which enters the top of the electroscope, and to which the pith balls are attached, serves to preserve the insulation by screening the instrument from rain. A prolongation of the brass rod at the stem terminating in a fine point at an elevation of several feet, completes the instrument of Kinnersley, but having found Singer's beautiful modification of Mr. Bennet's gold leaf electrometer, with its double insulation, extremely delicate and sensible, we would propose a modification of it for the purposes of an aerial electroscope.—A second glass tube of minute diameter, entering into the insulated one already employed, might be supplied with a thread of copper wire passing through its centre, terminating above in a lengthened and finely pointed brass rod, and connected below with the slips of gold leaf—the instrument should also be supplied with a protecting cap or dome. By this means the slips would be additionally insulated, and rendered still more sensible, and if two concentric cylinders of glass were used for the body of the instrument it might thereby be improved. The only additional apparatus required to ascertain the kind of electricity manifested is merely a stick of *sealing wax.* When the pith balls or gold leaves separate or diverge, by having acquired electricity under any circumstances in which they may be placed, all that is necessary to be done is merely to rub the wax gently on a piece of flannel, or simply on the sleeve of the coat, and approach the instrument gradually with it. If the pith balls or the metallic slips *close* or collapse, the electricity is *positive*, but if they, on the other hand, *separate yet more* the manifested electricity is *negative.*

CHAPTER IV.

HEAT AND MOISTURE, THEIR RELATION TO AERIAL ELECTRICITY—DE LUC'S ELECTRIC COLUMN—ITS APPLICATION TO CHRONOMETRY—CANTON'S BELLS.

By a statical law heated air ascends, and its place is supplied by colder, and of course denser air, and currents of air will be formed and move in the directions of the source of heat and rarified medium: the heated air of the tropical regions ascends, and the colder air of the arctic and antarctic poles will press forward to the equator, and thus tend to equalize the temperature of the earth; disturbing effects, however, will arise from local causes by which modifications will accrue in this equable distribution of heat, and when there arises an unequal distribution of temperature there will also exist an electric excitement. The superior temperature of the equatorial regions arises from the direct and unlimited impression of the vertical rays of the sun, while on other parts of the terrestrial surface these rays will strike more or less obliquely, and will thus be attenuated in the ratio of that obliquity. Change of volume is a source of heat or cold; air being attenuated, its capacity for heat is diminished, while heat evolves on the density of air being increased: for even during the formation of dew, heat is involved, cold being a previous occurrence; and when water passes into the solid form of ice, heat in like manner is disengaged, the cooling process being a previous and independent circumstance: thus too, when elastic vapour condenses in the cloud, heat is a natural and necessary consequence of that condensation, and the denser the cloud the higher will be the temperature at the moment of its formation. These are some of the sources of heat, and that greater abundance which we receive in the garb of light by day, finds a compensation again in the heat that radiates to the heavens from the surface of the earth in a clear and brilliant nocturnal sky: clouds check by their occasional interference this radiation and prevent the consequences which might ensue from that power being unrestrained and unfettered. By the process of evaporation aqueous vapour is constantly rising into the atmosphere, and when a maximum change of density is formed in the aerial medium there will of necessity be a precipitation of moisture—a change of temperature may also effect this purpose: now, moisture will serve as a conducting medium for the atmospheric electricity, and also diffuse or carry it away; while, therefore the evolution of heat will tend to raise the electric character of the air, that of moisture will subserve its discharge. Those collections of vapour, called *clouds*, are always electrical, : they may indeed be considered as composed of particles of aqueous vapour aggregated by electricity: and summer showers of rain are often invested with high positive electricity. The experiments of Mr. Bennet, and others clearly prove, that in evaporation and other natural processes connected with hydrometric changes generally, electricity is superinduced. In truth all atmospheric mutations and phenomena are intimately connected with electrical action; the changes that are rung in the superior regions of the sky, and the products of which salute on earth, are determined or modified by the diffusion of heat and moisture in the atmosphere.

Mr. de Luc's electric column is composed of circular slips of silver foil and zinc forming binary groups, these are enclosed in a tube of glass, and are pressed together by a screw at each end; when this tube is placed horizontally on a stand, and the metallic terminations are made to come into contact with a gold leaf electroscope placed at each end, the leaves diverge, and it will be found that the one connected with the silver termination of the column will evince negative electricity, and that in contact with the other end will be found positively electric. When two of these columns are mounted in a vertical position on insulated bells, with a metallic bar connecting the columns at top, a continued chime may be obtained by attaching a small metallic ball to the apparatus: the ball is suspended by a silk thread from the cross bar at top, and vibrating between the two bells to complete the circuit of the electric movement, an uninterrupted chime may be preserved, and has indeed been continued without interruption for several years: atmospheric air alone is necessary for its movements; but these oscillations are unsteady, and must needs be subject to variations in the moisture, temperature, and density of the atmosphere. In 1803, Messrs. Desormes and Hatchett first attempted to construct a dry electric column, but it does not appear that they succeeded, and M. De Luc's column, in 1809, was the first successful effort: Signor Zamboni's column was introduced in the same year, and by means of it he has endeavoured to establish a *perpetuum mobile:* there are in this construction two electric columns formed of gilt paper sprinkled with peroxyde of manganese, the piles as in the other case are vertical, and distant about six inches from one another, each pillar is surmounted by a brass ball, and a fine steel needle is made to move on a fulcrum; the longer arm of the lever being alternately attracted by each of the balls and repelled to the other, thus oscillates between them: Dr. Schübler, of Hofwyl, has proved that its movements are not connected with the electric state of the atmosphere, the principle of excitement being within itself. Heinrich, Singer, and Grindel, however, have incontestibly shown that its movements are unsteady and unequal, being subject to variable temperature and moisture. This elegant machine has even been employed, both in this country and in Germany as a prime mover to clock work, in the measurement of time: Mr. Ronalds, of London, has so applied it, but its oscillations being unequal, its chronometry must be also subject to variation. In some experiments on electricity Mr. Canton ingeniously employed three small bells to announce to him when his conductor was electrified; a metallic cap was attached to the rod to preserve its insulation, and such an apparatus is commonly used in electrical experiments. This simple chime consists of a metallic bar, which is, by means of a hook, connected with the conductor of the electrical machine, three bells are suspended from this bar, the two extreme ones being attached by means of a metallic chain, and the central one by a cord of silk; a metallic chain again connects the central bell with the earth, and in the space on each side between this bell and the others, hangs a small metallic ball by a silk thread; this ball incessantly vibrates between the bells at each end and that in the centre, imparting to it the electricity which has descended by the metallic chains to the bells at either end, the chain attached to the central one serving to convey it finally to the earth. We remember to have seen one of these chimes erected over a gateway, and attached to a lightning conductor in the neighbourhood of Zug, the capital of the Canton, and another in a garden on the route from Zurich to Basle on the Rhine, These chimes might be attached to the Paragrêles on gentlemen's pleasure grounds, and thus become a curious and interesting appendage, while they would announce by their peal the electricity of the atmosphere on the approach of the storm cloud.

CHAPTER V.

LIGHTNING IDENTIFIED WITH ELECTRICITY—METEORIC PHENOMENA—BOLIDES—ST. ELMO'S LIGHT——AURORA BOREALIS——METEORIC STONES—ELECTRICITY OF VOLCANOES.

There cannot be a fact more incontestibly proved than the identity of lightning and electricity: when an electrical battery is discharged, the flash and sound have a striking analogy with the lightning and the thunder. The experiments made by Dr. Franklin, and in the garden at Marly, have been already referred to, and the fact, that every experiment made by means of the electrical machine may be repeated with the lightning brought down by the electric kite, completes the chain of evidence. It has already been stated, that in repeating experiments on atmospheric electricity, considerable caution will be necessary, especially during a thunder storm; and if on approaching the insulated string of the kite, there is a sensation on the skin like that of cobwebs, it will be well to abandon the kite to its proper fate. Professor

Richman, of St. Petersburgh, fell a victim to an experiment of this kind by incautiously inviting the lightning collected by a kite, into his house. It appears that he had raised a conductor, and arranged a considerable apparatus for the purpose of collecting the aerial electricity. On the 6th of August, 1753, during a thunder storm, he and his friend, Mr. Sokalow, engraver to the Royal Academy, were standing by the apparatus, and Professor Richman had approached too near, for at this precise moment a flash of lightning from the conductor laid him prostrate] at the feet of his friend. The survivor describes the explosion which attended the awful catastrophe to have been exceeding loud, and the apparent vivid condensed ball of electric matter which struck Professor Richman at a foot distance, seemed to be several inches in diameter; the metallic rod was shivered to pieces, and the dispersed fragments left the mark of their form and dimensions on the clothes of Sokalow. Professor Richman had seventy rubles of silver in his pocket, which were not injured, but a clock that stood near was stopped, the door of the room broken, and the ashes of the hearth dispersed.

There are several luminous appearances occasionally seen in our atmosphere, which have very properly been ascribed to electric phenomena, such as *bolides*, or fire balls—shooting stars—

those phosphoric lights that flicker on the masts of ships at sea—the aurora borealis, and other phenomena of a similar description. *Bolides*, or fire balls, and shooting stars, have been ascribed to solid ignited matter, quenched it may be, by falling into the lower and humid stratum of the atmosphere: if a considerable electric discharge be passed through an exháusted receiver, it assumes the straightness and brilliancy of a falling star: shooting stars occur in such periods as are known to be most acted on by electric changes: they are prevalent in clear frosty weather, and when dry easterly winds, and a brilliant nocturnal sky obtain; also in the intervals of showery weather, and on summer evenings when well defined clouds are observed to move in a clear atmosphere. Sometimes these meteors are possessed of beautifully coloured light, and their scintillations are very vivid; prismatic tints were observed in the scintillations which were thrown off from the great meteor of 1783, and from the bluish light shed by it, the moon at Brussels appeared to be quite red: during a thunder storm fire balls are frequently observed to descend, and we must suppose them ascribable to the same cause. According to the observations of Professor Brandes, of Breslaw, falling stars move in all directions relative to a vertical line; the number which approach the earth are greater than those which move from it; and though these have undoubtedly a real velocity, it would appear that much of their apparent one is a mere illusion, dependant on the motion of the earth. Ali Bey mentions a beautiful meteor he witnessed near Bethlehem—"I saw appear, under the form of a star, two or three times as large and much more luminous than Jupiter or Venus in their greatest splendour, a meteor, which unfolded to the eastward a tail that appeared to me to be about two feet in length; meantime the meteor advanced toward the west, gently waving its tail in a horizontal direction, at an altitude of nearly 30°, or about that of the sun and moon. In the tail, which afterwards divided into several rays, were united all the colours of the rainbow in its greatest beauty."[*] *Falling Stars* are generally seen at night: we have, however, at least one well attested fact, of a falling star having been seen by Hansteen, at mid day: on the 13th August, 1823, at a quarter past eleven o'clock A.M. it passed through the field of his telescope in about a second, and resembled very much the unequal and somewhat serpentine motion of an ascending rocket.

Much uncertainty is connected with our opinions on these meteoric phenomena: that they are electric seems undoubted, but some contend that they come from beyond the boundaries of the atmosphere: there seems however to be no authentic warrant for such eccentric speculations. There are a great variety of kindred phenomena of an electric character, such as those flitting lambent flames that are observed to dance over still collections of water, called *ignes fatui*, which have indeed been supposed to be *phosphoretted hydrogene*, but to our vision the phenomenon is altogether different, and we believe dependant on electricity for its existence.* Those peculiar luminous phenomena which have been seen on the masts of ships at sea, and termed by foreigners, *Castor and Pollux*, *St. Elmo's light*, *St. Barbe*, &c. are akin to the diffuse and lambent electric light which is occasionally seen in stormy nights during the prevalence of rain, to fret the horse's mane, or attach itself to the tips of the umbrella, or the edge of the hat. Falconer thus notices the phenomenon—

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[*] Travels of Ali Bey, in 2 vols. 4to. London, 1816, vol. I. p. 231.

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* During the month of July last, we had the pleasure of witnessing this very curious phenomenon in the marshy grounds between Hertford and Stevenage, when on the mail coming from London, northward. The day had been dense and sultry, and toward evening a stratum of vapour hovered over the marshes of the valley; on the right, two *ignes fatui* started up suddenly, and at some distance apart: the appearance was altogether that of a solid ignited nucleus diffusing brilliant radii around it. Their locality as far as could be determined seemed to be clumps of rushes; at one period there appeared to be a flitting flickering motion, somewhat resembling that of a hovering insect; but this was not continued. The phenomenon lasted several minutes, and both were suddenly extinguished, the one after the other. It seemed to me difficult to conceive of electricity being presented under the attendant phenomena with which these were accompanied, and the entire features were more analogous to

> " High on the masts, with pale and vivid rays,
> " Amid the gloom portentous, meteors blaze,"

and the Baron de Humboldt also describes it :—" On observing the appearance of the masts, the maintop-gallant-mast head from the truck for three feet down, was perfectly enveloped in a cold blaze of pale phosphorus looking light, completely embracing the circumference of the mast, and attended with a flitting or creeping motion, as exemplified experimentally by the application of common phosphorus upon a board, and the fore and mizen-top-gallant mast heads exhibited a similar appearance in a relative degree. This curious illumination continued with un-

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those of an insect powerfully illuminated ; but whether some insect allied to the tribe termed *Gryllus gryllotalpa*, or mole cricket, has the power, under peculiar circumstances, as the Rev. Mr. Shepherd has conjectured, of evolving light* seems not altogether determined : this phenomenon might be adduced to plead in its favour. We have also witnessed a lambent flame gliding on the surface of a stagnant lake, but are of opinion this last is altogether distinct from the other, and depends on different principles.

* See Kirby and Spence's Entomology.

diminished intensity for eight or ten minutes, when becoming gradually fainter and less extensive, it finally disappeared after a duration of not less than half an hour." Electric stars or gleams have been seen to rest on the summits of spires and conducting rods on land: the lambent lights which are seen among the lofty range of the Himālā chain, as well as the Cordilleras of the American Andes, may be also assumed to be electric fire: luminous spots, we presume of an electric character, have been sometimes noticed in the air near the horizon, and appear occasionally very bright in Ohio, in the United States of America.

Dr. Franklin considered the coruscations of the aurora borealis as the effects of a continued but slow discharge of the atmospheric electricity surrounding the poles into the air above them. It may be considered as an electro-magnetic phenomenon, and the recent discoveries in that interesting branch of science seem to validate the position. The aurora may therefore be considered as an electric curtain, let down from the heavens in polar latitudes, and affected by the magnetic polarity of these regions: when a stream of electricity pervades the vacuum produced by an air pump, its dilute and diffuse light very much resembles the aurora borealis; the same variety of colour and intensity obtain in both, with the same coruscations and undulation—the streams also show that diversity of colour and character, now minutely ramifying and again beaming forth, and glowing in one diffuse stream of dilute light: it has therefore been inferred, that this curious and beautiful phenomenon is entirely referable to electricity passing through the superior regions of the atmosphere, where the medium must needs be exceedingly attenuated. Their altitude has been variously estimated:—the Honourable Henry Cavendish makes it 71 miles, Boscovich 825 miles, Bergman 468 miles, Euler extends it to thousands of miles, Mairan to 200 leagues, and Messrs. Dalton and Crosthwaite to 150 miles. Judging from these eccentric deductions, it seems clear that there must be some common and strange error in the estimate, and, altogether very questionable whether one of the entire number be a correct deduction: in the north-eastern parts of Siberia, the loud hissing noise which accompanies their appearance, so terrifies the dogs that accompany the hunters, that they will not move till the noise is over: Mr. Nairne and Mr. Cavallo have each acknowledged to have heard the sound that sometimes accompanies the exhibition in these latitudes, though it must be admitted that much scepticism has been entertained on this point; the fact, however, we think undoubted, and can remember, in our boyish days, to have heard this sound most distinctly, while numbers in

Scotland can attest the same thing—a species of fanning sound, like a thin curtain waving in the breeze. Now this simple fact proves that the calculations concerning the height of the aurora borealis are founded in error, because, even at the lowest computation, that of Mr. Cavendish, the tenuity of the atmosphere at the altitude of 70 miles is beyond the rarefaction of the best air pump ever constructed, and in such a medium all sound must necessarily cease, and be utterly extinguished: even Mr. Dalton has *altered* his estimate, for he calculates the *height* of the aurora of 29th March, 1826, which appears to have been immediately over the towns of Kendal and Kirby-Stephen, at *one hundred miles*, the breadth of the arch at eight or nine miles, and its visible length from any one place 550 miles.—In the Shetlands, the aurora borealis is called "the merry dancers," dimly seen immediately after twilight, above the horizon, and the streams beaming with refulgent light, assume various forms and shades of colour, frequently forming a diffused sheet over the visible hemisphere, exhibiting a spectacle of much grandeur: in Hudson's Bay they are said to equal, in effulgence, a full moon, and in Lapland and Sweden enliven and illuminate the path of the traveller. In north-eastern Siberia their splendour is orientally magnificent, moving with incredible velocity, and clothing the sky with inimitable brightness, "resembling a vast expanded tent, glittering with gold, rubies, and sapphires." Dr. Halley has ascribed their production to the same cause as that which is effective in magnetism; and Mr. Dalton's observations seem to prove that the direction of the beams of the aurora borealis is really that of the dipping needle: signor Beccaria considered the phenomena of magnetism as the result of a constant natural circulation of electricity from north to south, originating from several sources in the northern hemisphere: the aberration of the common centre of these currents from the north point he supposed to be the cause of the variation of the magnetic needle—the term of this declination from the centre the period of the variation, and the obliquity of the currents the cause of the dip of the needle: the stars are often seen through the electric curtain of the aurora borealis; in equatorial regions this beautiful phenomenon is rare, but in both polar regions it is not unfrequent.

There is not, among the entire phalanx of meteorological phenomena, a more extraordinary circumstance than those marvellous precipitations from the atmosphere, called *meteoric stones*,—a question, however, it must be acknowledged, which, though fraught with interest of a peculiar kind, is yet one perplexed with difficulty and intricacy. That our earth has been, from the earliest period of the history of man, visited by stony showers, is a well accredited fact, nor does there exist, in the wide extended circle of our philosophy, a phenomenon better established. Sacred and prophane history unite their voice in proclaiming this truth to the world; and the legends of the east, the annals of Greece and Rome,—all attest the fact; and after making every allowance for their fictions and their fables, their allegories and their orientalisms, the nuclei present the features of truth, and that man would not now be entitled to the name and epithet of a philosopher, who would presume to question these curious realities. Modern times have added numbers to their muster roll, and the catalogue is now extensive and complete: the first recorded fact of this kind is that which we find in the 10th chapter of the book of Joshua,* which destroyed the enemies of that celebrated leader in the way going down to Bethoron. The "stones of darkness"† may also be of this description, admirably illustrative of their appearance, the "colore adusto" of Pliny. Yet, how shall we interrogate these exotic beings—

"What are these that look not like the inhabitants o'th earth,
"And yet are on't——
"Are ye ought that man may question?"

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* Joshua, x. 11. † Job, xxviii. 3.

Wherever they have fallen, whether in intertropical climes or polar regions, they possess a similar character, and one so well marked as to stamp them peculiar—once seen, they are easily recognized, and the specimens that remain in the British Museum, and in those of the Continent, as well as in private collections, establish the position. We find attestations of these stony showers, as has been stated, to whatever side we turn—in the volume of sacred story, or the prophane page: and are of opinion that what is recorded in the "Acts of the Apostles,"* owned a similar origin. The expression is remarkable—"a worshipper of the great goddess Diana, and *of that* which fell down from Jupiter." It is true *the image* is introduced, but this is not in the original, our translators having supplied the words put in *italics*.† Of this description too may have been the stones worshipped by the Egyptians: such a stony mass was, according to Tacitus, also worshipped in Cyprus; and, agreeable to Herodian, the Phœnicians had an idol of a similar kind—the stone was of a conical form, a *black* colour, and reported to have fallen from heaven; and we think, from the description that Ali Bey has given us of the *black stone* in the temple of Mahomet, at Mecca, it also had a meteoric origin. It is called *Hhajera el assouád*, or *heavenly stone*, and is stated to have fallen at the foot of the mountain called *Djebel Koubiis*:—we have an interesting list of meteoric stones in a work entitled "*Della caduta di un Sasso dal aria ragionamento*," published at Modena, in 1766, by Domenico Troili.

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* Acts. xix. 35.

† Bloomfield's Recensio Synoptica Annotationis Sacræ, in loc. thus:—"Sometimes I am inclined to believe the *material* of the image might have fallen from the skies."

Livy describes a fall of stones on Mount Alba, in the reign of Tullus Hostilius, about 652 A.C.; the Senate doubted the reported fact, but inquiry verified the circumstance; it is thus mentioned:—"Haud aliter quam quum grandinem venti glomeratam in terras agunt, crebri cecidere cælo lapides." Plutarch* mentions a stone which fell in Thrace, at Egospotamus, which Anaxagoras supposed came from the sun, and it seems to have been of considerable size—"magnitudine vehis:" the person who saw it descend described the phenomenon thus:—"It hovered about for a long time; seemed to throw out splinters, which flew about like wandering stars before they fell; and at last it cast down to the earth a stone of extraordinary size."—Pliny, who saw this stone, informs us that it was of a dark burnt colour: he mentions another which fell at Abydos, and was there worshipped; and likewise another in Potidœa. Gassendi saw, on the 27th November, 1629, in a clear sky, a burning stone, about four feet diameter, fall on Mount Vaisir, between the towns of Guillaumes and Perne in Provence; it weighed 59lbs; the fall was accompanied with a noise like many cannon, and surrounded by a luminous circle, coloured like the rainbow.—In 1510, no less than 1200 fell in a field near the river Abdua; one weighed about 120lbs., and several exceeded 60lbs. —Soldani gives us an interesting account of a fall of stones in Italy, on the 17th June, 1794,—" a tremendous cloud was seen in Tuscany, near Sienna and Radicofani, coming from the North, about seven o'clock in the evening, and sending forth sparks like rockets—throwing out smoke like a furnace, and rendering violent explosions and blasts more like those of cannon and numerous muskets than thunder—and casting down to the ground hot stones, while the lightning that issued from the cloud was *remarkably red*, and moved with *less* velocity than usual; the cloud appeared of different shapes to persons in different situations, and remained suspended a long time, but every where was plainly seen to be burning, and smoking like a furnace. Its original height, from a variety of circumstances, seems to have been about the common region of the clouds."*—A shower of stones fell at L'Aigle, in Normandy, on the 26th April, 1803, and amounted to nearly 3,000 in number: the phenomenon was witnessed by several persons, and of these we possess in our cabinet several entire specimens, and fragments of others. In July, 1810, a great stone fell at Shahabad, in India, the fragments of which killed many persons, and, it is recorded also, burnt five villages: a meteoric stone fell in a field near to Major Topham's house, in Yorkshire, and a boy witnessed the fall. On the 9th and 10th September, 1813, several stones fell at Limerick, in Ireland; and on the 13th November, 1822, a meteoric stone fell at Epinal, in France; its size was equal to that of a six-pounder. The most curious recorded fact of this kind, as it relates to the death of an individual by an aerolite, is described by Signor Angelo Bellani, of Pavia, in the Giornale di Fisica e Chimica: and described as "one of those stones projected from the clouds, which struck with sudden death a Franciscan friar, of *Santa Maria della Pace*, at Milan, and which is open to the inspection of every body, in our museum." This is extracted from a work printed at Tortona, in 1677. The remaining monks of the convent, together with the Canon Manfredo Settala, having examined the body, discovered a wound, and probing it, found the fragment of a meteorolite, which seems to have penetrated to the bone; it weighed about a quarter of an ounce, and was not perfectly round, but rather obtuse angled, its colour somewhat resembled a burnt brick on one part, and on the other, seemed to be covered with a thin ferruginous crust: when it was broken it emitted a smell of sulphur. Without particularizing those meteoric stones, which have fallen within these few years, as at Juvenas, (of which we possess a fragment of considerable size,) &c. we may state generally that the British Islands have several times been the scenes of these extraordinary visitations, including the metropolis of the British empire; for an aerolite fell in London, on the 18th May, 1680. The spongy masses of iron, as that in Siberia, described by Pallas, and in many other parts of the world, are presumed to possess a similar celestial birth—like aerolites they contain *nickel*, and the spongy iron is quite malleable, and capable of extension under the hammer: Mr. Sowerby presented a sword to the late Emperor Alexander, made from meteoric iron in his cabinet, and the Esquimaux knives, brought from the arctic regions by Captain Ross, were found to be meteoric iron, and contained nickel: some of these are in the British Museum. The most prevalent opinion about meteoric stones is, that they come from the moon—a view once stoutly advocated by Laplace, but as the moon became too familiar an object, he at length summons them from regions even beyond the boundary of our solar system, as circumscribed by the path of *Uranus*—a point from whence even the telescopic vision recoils: we are inclined to reject this erratic opinion, and are as little disposed to give credence to the hypothesis which would regard them as mere chips or splinters thrown off from those lesser planets, sometimes called *asteroids*, which move between the orbits of Mars and Jupiter, and have received the names of *Ceres*, *Pallas*, *Vesta*, and *Juno*; and though their ellipticity is more eccentric than that of the other planets, we do not see how it can affect the question: in like manner we feel equally disinclined to believe that there is a zone of aerolites whirling round our "nether orb," that are somehow occasionally brought within the attractive sphere of the earth; an opinion, if we mistake not, that owns Dr. Brewster for its author. There might be some colour for all this speculation, were these aerolites *unattended* with extraneous paraphernalia—mere stones descending through the atmosphere; but we cannot forget that clouds and darkness, lightning, and all its accompaniments of coruscations and detonations, attend their descent: it seems foreign to all analogy to presume that their *mere passage* through the air is sufficient to kindle up the elements of lightning into a storm. With respect to the moon, nothing can be collected from thence to give colour to the supposition: we have unweariedly swept the lunar surface with excellent and powerful achromatic, dioptric, and reflecting telescopes, and are just as ignorant of the true nature of the lunar disc as before we began the investigation. There are some who would have us to believe that those silver annuli that seem to float in the abyss of space, and which, when the moon is in quadrature, are thrown into such sublime *rilievo*, are volcanic craters ; but all this is mere conjecture, and has no solid basis to rest upon, and as for the light observed on the lunar disc by Sir W. Herschell, Capt. Kater, and others,* it may, if we do not greatly mistake, be *always* seen when the moon is two or three days old, and if we remember right, has been recorded by Hevelius, and for ought we know, may find some analogy in the periodic gleams which flash amid the Himala range, and which seem to be electrical, or of a phosphoric description. The phenomena of the occultation of the stars by the moon, and those of the emersion of Aldebaran lately described by Mr. Bonycastle, are antagonist to the existence of a lunar atmosphere, a condition necessary to the material ignition of a volcano, though chemically speaking, sudden and energetic combinations manifest sometimes the phenomena of ignition and combustion : we speak, however, *generally* in this case.

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* In Vitâ Lysandri.

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* " Remarks concerning stones," &c. E. King, 4to. 1796. p. 4.

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* And.we believe, also with the unaided sight, by the Rev. Mr. Fallows, at the Cape of Good Hope.

In these assumptions one difficulty succeeds another in rapid succession, for after having *supposed* the existence of such volcanoes, we have also to impart to them a projectile force which exceeds belief: the meteor must set off with a velocity of 6,000 feet in a second of time, which is three times that of a cannon ball, and it would enter our atmosphere, moving at the rate of 25,000 feet in a second; now the calm manner in which these aerial beings salute our earth is incompatible with such an opinion; and after this double *petitio principii* has been granted, they should be confined to *specific* latitudes, while there is no latitude from the arctic to the antarctic pole, unhonoured by the celestial descent. We have them in our keeping to tell us " what stuff they're made of," and ought diligently to interrogate them, that we may learn what account they have to give of themselves: they are known to yield, under chemical analysis, *iron*, *nickel*, and *chromium*, and sometimes calcareous and other earthy and combustible matter: now it ought never to be overlooked or omitted in this estimate, that all these are found indigenous to our earth; the *proportionals* vary, it is granted, from any other mineral mass yet discovered among the rocky features of the globe, but then, atmospherical electricity can ring a new change, or introduce a note unknown to terrestrial minerals. Electricity can suspend or unhinge the affinities considered *natural* to bodies, or impart an entirely new one; thus easily may combining proportionals be changed, and another order in relation to their constituents be introduced. No new *material* has ever been discovered in them—merely such as are common to our globe, and familiar to us, and the fact that they all possess the same relation of parts proves not merely a *common source*, but a *common agent in their production;* now the productions of terrestrial volcanoes vary exceedingly, while these have a common character, and the slight shade of difference in some is scarce perceptible; "non omnibus facies una, nec tamen diversa." All that we require is a vehicle to charioteer their constituents aloft—and these are numerous; winds, (the whirlwind and the tornado,) gaseous media, specifically lighter than air, as hydrogene and its compounds; evaporation; or even atmospheric air when expanded by heat, and the elasticity of which is increased by the vapour it may contain: volcanic eruptions too may toss their dust into the air, and that to an immense elevation, as has been shown by Mr. Poulet Scrope in reference to the enormous altitude to which ashes and fragments of stones were launched in a recent eruption of Vesuvius, namely, that of November, 1822. Fine sand wafted by the wind from the coast of Africa, fell on a ship 600 miles distant at sea, and we possess a quantity of finely divided volcanic dust, projected from the volcano of St. Vincent, and collected from the deck of a ship three hundred miles from the island; in some of these eruptions, the finely divided volcanic matter was raised above the lower atmospheric current, and carried, contrary to the direction of the wind, to Barbadoes. I have analysed a liquid collected in the crater of a volcano in one of the Lipari Islands, presented to me by the Earl of Mountnorris, and in it have found iron, nickel, and the usual constituents of meteorolites. The fall of meteoric stones at Radicofani, in Tuscany, took place the very day after the great eruption of Vesuvius, which overwhelmed *Torre del Greco:* that of Epinal was immediately after an eruption of the same volcano, and many more instances might be adduced to prove that such remarkable concretions are precipitated when the atmosphere must necessarily be loaded with volcanic matter. The atmosphere becomes as it were, to speak chemically, saturated with metallic matter and earthy particles ejected from volcanoes, or carried up by evaporation or other causes, and these will necessarily be diffused over an immense surface where they float in the superior regions of the air, till the lightning darts through them, carrying, like a ploughshare, accumulated matter in its progress, and, by the powerful electrical attraction thus excited, these particles will be drawn into the vortex of the lightning, instantaneously; for the lightning finally encountering an electricity of an opposite kind, an explosion ensues, and the collected mass is instantaneously fused and agglutinated, while the meteorolite thus formed tumbles to the ground; and it may also be very easily supposed that immense tracts of earthy matter, and metallic oxydes imbued with their peculiar electricity, might encounter in their progress metallic matter, or carbonaceous, or other inflammable matter, also scattered over an extensive region; now this last would be naturally invested with the opposite electricity: such a conflict would be terrible, and evolve the splendours that shroud the sublime phenomenon. The electric fire would kindle the gaseous media, and the result would give rise to aqueous vapour, while the explosive electricity would instantaneously fuse the included materials, and immediately collapse into the focus where the opposite electricity was condensed: the crust of meteoric stones seems plainly to indicate that they have traversed an aqueous medium, such as this supposes.

We therefore do not see the necessity for considering meteoric stones *extra atmospheric*, simply, because we possess all the conditions necessary for their production—vehicles sufficiently active and extensive to carry aloft the *materiel*, and an agent powerful enough to alter the arrangement of their contents, and fuse them into a solid mass: on any other view of their production all is gratuitous assumption: the figure may be bold and daring, but the elements of doubt enter into its composition, and we perceive nothing solid or satisfactory. We cannot doubt that the power of lightning is sufficient; those extraordinary productions, the Sand tubes or *ceraunian scinter*, found in Germany, and particularly at Drigg, in Cumberland, fine specimens of which we received from the late Mr. Irton, of Irton-Hall, amply attest the intensity of this power, and if we are not misinformed, recent evidence of their formation has been presented on the continent. One of these tubes finely glazed and enamelled by lightning penetrated to the depth of nearly thirty feet, exclusive of what might be called the fibres of its root: we have also a specimen of fused amphibole from the summit of Mont Blanc. When a chip of meteoric stone is submitted to the jet flame of the compound gas blowpipe, as we have observed, it is fused into a *magnetic bead:* this we found in fragments taken from specimens of the meteoric stones of L'Aigle, Juvenas, &c. in our cabinet. If other evidence were wanted for the completion of our conclusions, we think it completely supplied in the phenomena attendant on the fall of the meteoric stones which took place in the commune of La Baffe, department des Vosges, on the 13th

September, 1822, as described in the *Annales de Chimie*, and attested by Nicholas Etienne, the mayor of Baffe, &c. A violent thunder storm commenced about four o'clock, A.M. the air being quiet, and the sky filled with electric clouds: the lightning was intense, and abundant, and frequently directed to the ground: the thunder was loud and sharp. At seven A.M. the storm was over Baffe, when the inhabitants suddenly heard a noise, quite distinct, like that of a carriage dragged with violence over a rough road: its duration was full seven minutes, and its intensity at last frightful—finally, a dull explosion was heard, when the meteor struck the ground: the size was that of a six pounder, and it was quite hot. At the moment this phenomenon happened, the storm was near the zenith; thunder was heard both before and after, and rain fell with great violence: it seems impossible indeed to conceive otherwise than that the aerolite must have been the offspring of the storm.

We are of opinion that lightning often collects in its progress *extraneous matter* from the surfaces it pervades, and think that we have had in the examination of some effects of lightning the clearest evidence that such is the fact: lightning in the spring of 1822, struck a horse chesnut, at Sarsden, Yorkshire; a ferrugino-resinous substance oozed out from the bark about five feet from the surface of the ground, and on analyzing a specimen submitted for analysis we detected the presence of *nickel.* M. Fusinieri has made some exceedingly interesting experiments which seem clearly to prove the transference of ponderable matter in the electric discharge, and the peculiar odour of electricity and lightning is only explicable on a supposition that it is attributable to the presence of this extraneous matter, while the *colour* of the electric light and that of lightning may also be dependant on foreign combinations; thus it is red from iron or steel, (it was *red* in the lightning that accompanied the fall of meteoric stones near Radicofani,) green from silver, and so on. In order to understand clearly Monsieur Fusinieri's truly interesting experiments, suppose the Leyden jar to be surmounted by a ball of gold, and the ball of the discharging rod to be of silver; on the discharge having taken place a trace of gold will be found on the silver ball, and a trace of silver on the ball of gold. This reminds me of an electrical experiment I made many years ago, and which appeared in the Philosophical Magazine, of a somewhat analogous kind; the ball of the rod entering into the Leyden jar was coated with China ink, as was that of the discharging rod; a vertical card was placed between and the electrical discharge effected: the card was as usual perforated, and a bur raised on each side, but besides all this there was a circular portion of the China ink displaced from *each* ball, and in the centre of both an indent discovered; we introduced this experiment among others to prove a *double current;* but which the late Mr. Singer, if we remember right, contended was an evidence of what he called *expansion:* Fusinieri's experiments, however, clearly prove that our opinion was correct, and M. Moll of Utrecht, subsequently modified this, and at his request I transmitted a detail of these experiments to him. We subsequently made the following experiment in reference to that of Fusinieri—several folds of gold leaf were placed between the central leaves of a half quire of paper, and it was found when a powerful electrical discharge was passed through them, that the entire passage from the centre outwards to each external surface was stained with the purple oxyde of gold. Let us finally consult the phenomena that announce the formation and fall of the meteoric stone: a peal of rolling thunder arrests the attention, and the vision being directed to the ominous spot, perceives a brilliant globe emerge from the dark cloud that conceals the elements of explosive fire, and on the wings of flame direct its flight to the earth; when at length the meteor has arrived, and the aerial stranger is interrogated by "the torture of the fire and inquisition of the forge," as to its birth and origin, there is nothing elicited we think that can shake the conclusion, that the elements are terrestrial, and the proportionals the mere exotic growth of the electric movements that pervade the exalted regions of the sky.

Volcanic eruptions are always accompanied by a highly electrified state of the atmosphere: we are informed by Mr. Ronalds,* that he found in his experiments, on Mount Vesuvius, in June and July, 1819, the atmospheric air *constantly* positive, and that the intensity increased as the sun rose, except when *influenced by explosions of the volcano*, and the variations of intensity occurred very frequently. The difference between the highest and lowest degree of intensity amounted to nearly one-third of the mean intensity—these variations occasionally accompanied changes of wind, which frequently occurred six or seven times in the course of half an hour. Signor Gemmellaro relates the following curious electric phenomenon which occurred on Mount Ætna, on the 2d June, 1814:—" Carbonaro, one of the guides and the most advanced of the party, felt his hair stand on end; his forehead and face benumbed, and he heard a hissing noise. He took off his cap, and his hair became more bristled, and the whistling noise more powerful; the traveller nearest to Carbonaro also heard a humming sound, and asked the guide what it was; in the meantime they approached each other, and were pleased with the magic sound. The traveller turned to call his companion, who was at some distance, and made a sign to him with his hand; the hand, when raised, produced a much stronger sound, so much so, that moving the fingers singularly modulated it. Finally, the three persons having joined, they experienced great pleasure, as, with moving their fingers, they produced the above extraordinary effect." During the convulsions of the volcanic eruption, lightnings are seen to dart their forked fires across the sable mantle of clouds which issue from the crater, so well described by Sig. Monticelli, of Naples, in the eruption of October, 1822, when Vesuvius exhibited the magnificent spectacle of a blazing cataract of liquid fire, from the flowing of the lava, while dense and dark pillars of cloud, mingled with flame, ascended to the heavens, and the lightning amidst the sable canopy displayed its mighty coruscations, and scintillations resembling "l' enorme e rigoglioso pino"—of which we have the following particulars by Sigs. Monticelli and Covelli. On the 22nd of October, 1822, an enormous column of fire, two thousand feet high, rose from the top of the mountain, and lightning ascended from the crater, in the form of a pine, followed by numerous zig zag flashes which continued unceasingly to penetrate the rising cloud of cinders. Toward the middle of the night, the paroxysm of the volcano seemed to have been at its acme: the play of electricity, which embellished the elevated regions of the clouds of sand, became stronger, and acquired fresh vigour: at this moment the heavens presented a very unexpected scene, zig zag flashes of lightning passed in such quantities, either from the border of the clouds of sand into the air, or from one cloud to another, so that the edges appeared fringed with light, similar to an electric disc, throwing off continued flashes of light. On the 23rd, the continual discharge of the lightning, accompanied by awful thunder, fell on the most elevated points of the churches, houses, and trees: numberless flashes were observed to serpentize on all sides, coming not less frequently from the earth than from the heavens: the volcanic sand which fell on the 23rd, and following days, was positively electrical. Prior to this memorable eruption, I descended into the crater several hundred feet, but am informed by a friend, that from its present condition this is now impracticable.

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* Professor Brande's Quarterly Journal, vol. 14. p. 332.

We consider the *earthquake* connected with volcanic agency;—the air will be found highly electrical, and immense are the distances to which its influence extends: during the earthquake at Lisbon, 1755, the celebrated St. Winifred's well, at Holywell, suddenly ceased to flow, and continued so for three days. The late Dr. Muter a clergyman of the Church of Scotland, informed me, that, on the morning of the day of the earthquake, he and a friend were walking together, on the verge of Loch Lomond;—the lake was then remarkably tranquil, unruffled by the slightest agitation, the waters, however, suddenly rose eight feet above their former level, and had well nigh swept them away. The great earthquake which occurred on the 13th of August, and was renewed on the 5th of September, 1822, that destroyed Aleppo, and buried more than 20,000 of its inhabitants, extended to many other towns in Syria: the shock was felt at Damascus, and in the Isle of Cyprus. In this case, the *vertical* undulations were an extraordinary feature, these being almost exclusively in a lateral direction: it preceded little more than a month the eruption of Vesuvius already referred to.

CHAPTER VI.

PHENOMENA OF VEGETATION——DUTROCHET'S THEORY—ANIMAL ELECTRICITY—ASCENT OF THE SPIDER.

IT seems highly probable that the entire chain of the phenomena of vegetation is influenced by electricity, or electric currents: electric gleams were first observed by the daughter of Linnæus to play in the evening on the flowers of the Indian cress, and the attachment of dew to the points of leaves appears connected with the same principle. The recent beautiful theory of Dutrochet seems to confirm these observations:—according to our author, the roots absorb water with such soluble matter as may be present; this flows upwards to the leaves, through the *lymphatic tubes* of Decandole, and which are found both in the soft and hard wood; this fluid solution as it ascends, absorbs *laterally* a portion of the already elaborated and assimilated sap, to form the leaves. Being carried up to the leaves in spring, the sap there undergoes a chemical change, by evolving oxygene by day, and carbonic acid gas at night: thus assimilated, it again returns, descending through the bark and soft wood, and giving off *laterally* in its descent, elaborated sap, finally changed into bark and wood. Thus the radiated tracheæ of the wood give off and disperse laterally the ascending juice of the lymphatic tubes, and those of the bark the descending or nutritive and elaborated juice to the bark: the first adds a new layer of *alburnum*, or young wood, and the second a new layer of *liber* or inner bark. M. Dutrochet found an interesting illustration of this in some of his experiments: he took the *cæcum* or blind gut of a chicken, and having nearly filled it with milk, it was immersed in water, when it was found to be *absorbed laterally*; after sometime the milk underwent chemical decomposition, and the water that had been absorbed was *expelled*, by those orifices through which it had previously entered. Suppose a glass tube had been inserted into the cæcum, it is evident that when the water was absorbed, the liquid must have risen in the tube, as exemplified by Dr. Hales, in his experiments on the bleeding vine; and still more interestingly so in one made by Mr. Braddick, who, having attached a bladder to the orifice of a bleeding vine, found that in 24 hours it expanded, and became as hard as a cricket ball, and in some hours after burst with explosive force. A curious fact was lately communicated to me, and which we consider in some measure corroborating Dutrochet's theory: a twig was picked up in a wood during a severe frost, and part of its bark detached; from this denuded surface an innumerable quantity of most minute capillary filaments of ice protruded; they were parallel to each other, and horizontal. It appeared that the sudden expansion of the fluids included in the tubes already described, had projected jets in a horizontal direction through the lateral orifices, and which were suddenly congealed, presenting the curious phenomena already described: as a verification of Dutrochet's opinion, it should be remembered that electricity is always efficient in every chemical change; therefore, when the milk passes into the acetous fermentation, its power is exemplified, and must act very dissimilarly during that phenomenon to what it does before decomposition ensues; the ascent of liquids in virtue of capillary attraction is a problem the solution of which has perplexed the inquirer, and in truth, we know not how it is to be explained apart from electrical attraction. The substitution of *recent blood* for milk in Dutrochet's experiment beautifully illustrates his position, because the finally expelled liquid will be tinged red by the coloured globules of the blood, and thus dye the liquid medium which surrounds the cellular tissue.

There are peculiar phenomena in vegetable physiology wherein an unusul quantity of limpid water is secreted by the plant, and which in all probability is connected with some organization peculiarly acted on by electricity. Thus, what has been called the *wild pine*, an exotic found in South America and the West Indies, and parasitic on the trunk and branches of some trees, is composed of folliaceous bags, serving as reservoirs for water, obtained from the atmosphere, in the form of dew or rain. These severally contain from a pint to a quart of water, and an appendage prevents its evaporation; it becomes an interesting resource against thirst, both for the inferior animals and for man, and no doubt the former class are well acquainted with these providential supplies; at least it has been ascertained that animals of the *Simia*, or monkey kind, are no strangers to the fountains of supply contained in the pitchers of the *Nepenthes distillatoria*. In the case, however, of the *wild pine*, as well as the *Sar racenia adunca*, &c. in which last are also pouches for the reception and retention of water, they may be considered as vegetable tanks or cisterns: it is different in the *Tillandsia*, or "water with" of Jamaica, since here, as well as in the *Cissus latifolia* of the East Indies, it is evidently a secretion of the plant; a piece of the former, two or three yards long, supplies a copious draught of water, and when the latter is cut, it is found so full of sap that a continued stream flows out. The watery fluid found in those curious folliaceous adjuncts, the *pitchers* of the *Nepenthes distillatoria*, is evidently a vegetable secretion, because we have seen it contained in the pitcher *before* the lid had opened, and shall elsewhere give our chemical examination of this liquid, as well as a description of the curious mechanism of the lid. There is a phenomenon in vegetable physiology to which we have paid considerable attention, and we last summer observed an extraordinary instance of the kind; we describe it here, especially as believing it to be associated with electricity. Doubtless many streams, rivulets, and rivers, owe their source and vigour to a similar cause, and have had their occult springs amid the deep recesses of the forest: rain will always be more frequent and copious, and oftener repeat its periodic return, to the spot shaded by trees, than in open districts of the country, and apart from them; a fact of the utmost importance in the *formation of roads*, and should never be lost sight of. The intelligent traveller, in looking around him, must feel persuaded of this palpable truth: many a rill, and even river, have disappeared where woods have been levelled, and thus the great features of a country have been changed, and we doubt not but rivers have rolled in ancient Caledonia before her forests were felled, and of the existence of which we now have no memorial, except in the organic remains occasionally exhumed from the deposit of the channel of a former river; thus our intelligent friend, Patrick Neill, Esq. has clearly proved that the *beaver* was once indigenous to Scotland: it is, however, America that presents less equivocally the picture consequent on dried up rivers. The geologist should not omit this important truth in his speculations, for it will certainly solve satisfactorily some phenomena in alluvial deposits.

It must have been observed, that under circumstances when the roads have been parched and dusty, the surface of the ground round particular trees has been so saturated with moisture as to appear it had rained copiously on these favoured spots, and no where else, and according to our numerous observations, the *elm* seems remarkably prominent here. Glas, in his account of the Canaries, informs us that in one of these islands, the entire supply of water proceeds from a vegetable source, and that it is measured out to the inhabitants under the jurisdiction of the municipal authorities; dense clouds proceeding from the ocean are attracted by a tree, which grows on the declivity of a hill, and this vapour here condensed, falls in the form of a shower into a tank beneath: it is therefore called the "raining tree." In the month of July last I witnessed a striking instance of this kind in the vicinity of Stafford, on the Lichfield road; clouds of dust rose on the main road, and a dense fog hovered over it, but no moisture was precipitated except in the vicinity of the trees and hedges, and here the deposition was considerable, but especially in the case of a lofty insulated Lombardy poplar; where, the fall was so considerable that it might have been used as an admirable *shower bath*, and so complete a rivulet was formed as might have been directed with effect to turn the wheel of a small saw mill. Thus, rivulets may be created by plantations, and have been formed by them; the pond embossomed in woods will rarely dry up, and its supplies will be seldom exhausted: while gentlemen may hereby obtain a useful hint in reference to ornamental landscape. By a considerable increase of our woods the climate may eventually be entirely changed, and, on the other hand, by the introduction of trees, arid wastes may be softened down into a genial soil, susceptible of cultivation; even parched islands, such as Antigua, &c., might be reclaimed from that drought to which their inhabitants are frequently doomed. It is in the *oases* of the desert that wells are found.

These remarks may be considered somewhat exotic, though all are, indirectly at least, allied to the subject, and it is presumed that their interest may be found sufficiently apologetic.

We have been informed that a gentleman who has paid great attention to experiments on electricity, discovered, one evening, on his return home, the spiny summits of a thorn singularly studded with stars of electric light: it may be added, that Dutrochet is of opinion that negative electricity imparts the powers of *absorption* and positive electricity those of *secretion*.

The electric powers of certain descriptions of fish have been long known, such as the *torpedo*, *silurius electricus*, *gymnotus electricus*, *trichiurus indicus* and *tetraodon electricus*. While the *torpedo*, a flat fish, of the ray kind, was well known to the ancients, it does not appear that the peculiar properties of the *gymnotus-electricus* were recognized before the end of the seventeenth century; and it was Mr. Walsh that first identified this singular phenomenon with electricity. Humboldt gives us, in his "Personal Narrative," an amusing account of the method practised in South America for catching the electrical eels, by means of wild horses forced into the water, the electrical eels becoming finally exhausted by an expenditure of their energy: by these animals, as in common electricity, the shock is freely communicated through conductors, but is not transmitted through electrics, and when the shocks of the larger gymnoti are passed through an interrupted circuit they even yield the electric spark; the electric organ consists of an extensive series of irregular columns divided by horizontal partitions which expose a considerable surface; and the interstices seem to contain a fluid, which may give rise to the electric influence. The torpedo is found in the Mediterranean and North Seas, rarely exceeding 18 to 20lbs. weight, and the rapidity with which they communicate their shocks is considerable, sometimes amounting to fifty in a minute and a half: it should seem that the shock is dependant on the will of the animal, and each shock is accompanied by a depression of the eyes, while the intensity is stated to be four times stronger when the fish is insulated and surrounded by air. We were informed by Signor Mojon, professor of chemistry in the University of Genoa, when in that city, that it was endeavoured to ascertain by experiment, whether a series of torpedos, arranged in separate tubs, and conjoined with conductors, in the manner of the *Couronne des Tasses*, would decompose water, as in common electricity: the attempt, however, was unsuccessful, nor do we think that this might have been reasonably expected, because it would have required a series of *simultaneous* shocks, as well as a continuous succession of them to have produced this effect.* Heat seems to increase the electric property in these animals, and we were told that the *temperature* of the water in which one of these fish was placed having been accidentally raised too high, Mr. Walsh, by incautiously handling it at the moment, received so violent a shock as to lay him prostrate. On the authority of Spallanzani, the dying torpedo communicates its shocks more frequently than at other times, but they are then feebler, and the same naturalist assures us that the youngest torpedo can exercise the property in question. The gymnotus electricus, or Surinam eel, abounds in the rivers of Surinam and Senegal: it is about three feet long, generally, but occasionally met with 10 to 20 feet long, sufficient even to kill by its electric power a human being: the nerves immediately connected with these organs are larger than in other parts of the system: these have a reference to temperature, and a comparative relation to the media of air and water, the latter being an inferior conductor, and the former, when quite dry, being an electric of a superior kind, and only changing its character by means of the watery vapour it contains. We are of opinion that the electric organ of the *torpedo*—perhaps we may extend it to other electrical animals—is more subservient to the process of *digestion* than to that of catching its prey, and this opinion is also maintained in a late volume of the Transactions of the Linnæan Society. The curious experiments of Dr. Wilson Phillip go to prove that the galvanic influence produces an analogous result to that of the nervous power, and seems, in his researches, to have been successfully substituted for it. From the preceding observations it is evident that the animal machine is intimately connected with electricity, and infer this applies not merely to those extraordinary fish now reviewed, but to *all* animals, though in the torpedo, &c. it be most conspicuous, and the energy more concentrated; it is sufficiently obvious, therefore, that the atmospherical electricity must affect the animal system more or less, and modify its powers of action; and the same thing applies to the process of vegetation: it is well known that when we rub the back of a cat, electric sparks are copiously emitted, but it is not so generally known that if we do this and lay one hand on the throat of the animal, and apply the other to the back, we shall receive a distinct electric shock: an experiment we believe first pointed out by Glover.

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* A posthumous paper of that much lamented and distinguished philosopher, in reference to this subject, has been lately laid before the Royal Society.

We have elsewhere ascribed the curious phenomenon of the *ascent of the spider* into the atmosphere to electricity, and the numerous experiments we have made on this subject seem to put the matter beyond doubt: by these experiments we clearly discovered, in our apprehension, that the thread or threads they propelled in the vertical plane, or at variously inclined angles, were invested with *negative* electricity, and that when there is a *fasciculus* of such threads, the fact of their being all imbued with the *same* kind of electricity is evident in the divergence of the threads, and the mutual repulsion which exists among them. We have there already stated, that when the weather is dry, and the air is *positively* electrical, under such circumstances the ascent of the spider becomes a natural and necessary consequence, and in such weather the spider will *always* ascend; it has been also mentioned, that on the approach of rain, &c. the air is negatively electrical, and at such periods we have also proved, that the spider cannot ascend, but occasionally thread and all are seen to fall to the earth like a stone. In a negatively electrified atmosphere this is the proper consequence: now, we have found this ascent of the spider to take place during an *intense frost*, and with great velocity, as well as in summer and autumn; and have met with aeronautic spiders on the Lake of Geneva, and on the Mer de Glace, which flanks Mont Blanc. A Mr. Blackwall, however, (we presume in consequence of Mon. Gay Lussac having found that a soap bubble would not ascend in a room, though it would ascend out of doors, and ascribes it to warm currents of air ascending from the earth's surface) imputes the ascent of the spider to a supposed evolution of heat; we cannot suppose that Mr. Blackwall has seen the experiments to which we advert, since he does not allude to them, but we presume they must carry conviction to the mind. We know not whether to understand Mr. Blackwall as inclined to deny the power of propelling threads to spiders; but if he is to be so understood, we must confess ourselves astonished: and think that there are several other untenable propositions hazarded, but feel anxious to deal with facts not theories. We are favoured with an interesting communication on this curious subject from our ingenious friend, Mr. Dillon, of Wrexham, an accurate and cautious observer, and zealously attached to natural history, and it is with pleasure that I transcribe his observations, which all tend to corroborate the view sustained, while they have novelty to recommend them to our notice and attention: " The facts which earliest arrested my attention, I can remember, was the great deposit of moisture upon the webs of certain descriptions of spiders, those for instance, spun in the hedges, or on their banks, and on the grass in the open fields; and the entire absence of any on the threads of the aeronautic spiders, so long as they remained attached to them: in the former instances the webs were all *detached* from the living body of the spider. From some experiments which I have made there is reason to believe that moisture alone, without any other kind of food is calculated to sustain the life of spiders, (some species at least) for a very considerable length of time.

“ I have, three or four different times, seen spiders being borne down in the air, and falling, as it were, from great heights, by reason of, as I conceived, an accidental coiling up of their lines into flaky balls, something resembling the condition of those gossamers which are so frequently noticed descending from the air ; when it has evidently been contrary to the intention, (shall I say ?) of the insect, who seemed very busy in the meantime, and standing on the surface, has suddenly darted out a new line which has carried him aloft again, while the heavy ball has fallen quite to the ground.

“ On the first ascent of a spider from the tops of wooden palings, for instance, it seems to be regardless of the direction of the wind, and not to depend upon it for any assistance whatever ; for I have very frequently noticed a single thread, shot out right in the teeth of the wind, (as a sailor would describe it) nor did it seem to experience any resistance. Sometimes in a slow and regular descent from the air, they have at first evinced a design to alight near the spot where I have been standing ; but, upon a near approach, would decline doing so, and rather sailing around me, finally ascend again, and not always in the same direction they came from.

It is not at all times a single line which is the medium of ascent; sometimes it is a fasciculus of divergent lines, and not unfrequently in the form of two such fasciculi; I think the variation will be found connected with the size of the spider: while in the air they can communicate a strange spiral motion to their line, which seems to have the effect of altering its course.

" The most remarkable descent of the gossamer, which has happened for many years, was on Sunday, October 1, 1826: it was very extensive also, being noticed here, at Chester, Wigan, and Liverpool, on the same day, and in all which places its appearance seems to have been precisely similar. The descent of the gossamer will generally be found to precede rain a short time, and sometimes accompanies it, when the weather has been previously dry for some time, and then it presents a very remarkable appearance, and just such a one as I can imagine Hook to have witnessed, when he formed the notion of the clouds being composed of that material.

" On the 13th of March last I was observing a very extensive ascent of spiders, chiefly of two kinds only, and rather of large size: they mostly ascended not by single threads, but the whisk shaped fasciculi as before described. I remarked they did not all ascend and float away in the same direction, but frequently directly opposite one to another. I had with me an accurate pocket compass, made by Jones, of London, which enabled me to determine with precision, that in all such cases, without one single exception, the ascent was made at right angles with the magnetic meridian."

It would be out of place here to enter on an elaborate examination of the principles of those numerous experiments by which we have sustained the proposition, that the ascent of the spider into the atmosphere is entirely an electrical phenomenon; but which Mr. Blackwall, in terms neither measured nor courteous, has endeavoured to controvert: his opinion has already been glanced at, but we may safely rest the question at issue on its own merits, and leave it with the intelligent mind. I shall elsewhere* consider his view of it, which, however, has neither novelty, nor, it is presumed, correct data, to recommend it, at considerable length, and adduce experiments confirmatory of the principles assumed of its aerial ascent, in addition to those already before the public. A few remarks, however, connected with the question may not be deemed irrelevant in this place: our friend, Mr. Dillon, in a subsequent communication, dated 5th May last, has the following observations in reference to this subject:—" I think I have reason to be confirmed in what was once only conjecture, namely, that the number of divellent threads by which we have seen them ascend, has always a relation to the size of the spider, and that it is only the very smallest, such as the *obstetrix*, for instance, that eject single lines: and it occurs to me that all your arguments are enforced by the consideration, that this season they have scarcely at all appeared." In some remarks on this question in Mr. Loudon's Magazine of Natural History, I quoted an extract from a letter received from my friend, J. E. Bowman, Esq. F.L.S. and which describes a phenomenon inexplicable except on the principles I have assumed as the inference of direct experiment: the insect in this case ascended by two distinct fasciculi of divergent threads, separated by an obtuse angle, (a figure descriptive of the phenomenon accompanied the communication,) and it has been quoted by Professor Brande in his Journal of Science, as presumptive, if not conclusive of the opinion, that the threads were electrified. Mr. Blackwall, seems, however, either not to know, or to forget, though long ago proved by Bennet and others, that when air is blown on the cap of a delicate electrometer, the instrument will manifest acquired electricity; and yet he adduces the circumstance, that a spider insulated by water will not propel its thread of escape unless blown on! and that a spider will not eject threads wherewith to effect its ascent, unless favoured by the wind or a current of air ! All which circumstances, even by his own showing, entirely corroborate our view of it, and can have no possible connexion with his hypothesis, which assumes, that the aeronautic spider ascends, being borne up by heated currents, constantly emanating from the surface of the earth. In the first place, the existence of these supposed currents is entirely gratuitous assumption, and altogether problematical: even if their existence were proved, they would remain unconnected with the cause which somehow *forces* them to eject threads, namely, a current or stream of air ; on this supposition, every thread propelled " in the teeth" of such a current of air must necessarily be vested with electricity. When the atmosphere is positively electrical, the ascent of the spider is more or less rapid, correspondent with its intensity : in the cloudless sun beam, and a positively electrical medium, an ascent is always secure and certain, and a descent as certain, when the air changes to more or less of a negative character ; thus it is at *night* that their fall is so uniform, and the numbers are incredible ; during this season of repose, they weave that tissue on the ground which serves to entangle the dew drops, and which supplies a beverage essential to their existence. We have mentioned in our researches, &c. a fact which illustrates and corroborates this descent, namely, the vast numbers that fell from the atmosphere during a *feu de joie*, the atmosphere being rendered negative in consequence of the fire of the musketry; and it is well known, that when the Park guns are fired, the windows of the treasury, &c. are imbued with electricity. Besides is it not notorious, that the fall of the aerial spider and the gossamer are the presage and precursors of rain? Need we add that the electric character of the atmosphere has veered round to negative? Experimentally we have recently found that a soap bubble will ascend rapidly in the electrified atmosphere of a room. On Tuesday, 28th of July last, I made many experiments in a hay field, near Hull, with the aeronautic spider, which appeared quite conclusive against Mr. Blackwall's hypothesis of heated currents or emanations. One of these experiments merely, may suffice, for detail:—Three aeronautic spiders *ascended from the same spot*, when each one *moved in a different direction*; clouds afterwards collected and obscured the sky, and all my attempts to favour their ascent were utterly unavailing, not one succeeded, they fell like lead to the ground. The temperature in the mean time changed together with the aerial electricity, and here I may pay a passing tribute to a most sensible and elegant instrument, and one which I have, for its susceptibility and delicacy, found in-valuable in many of my observations; I allude to the *Thermomètre metallique,* of the late Mon. Breguet, an instrument I purchased in 1819, from that ingenious *mechanicien.* It announces, with invariable certainty, the *transit of a cloud over the disc of the sun,* and I have in some cases found it superior to the Etherioscope of Leslie, which I had employed in France and Italy, in 1818, and a modification of which, ensuring greater sensibility, I have since proposed. It cannot be supposed that the aeronautic spider rises on the elastic wing of *radiant caloric,* because in such a case the insect *should not descend* in a clear nocturnal sky; for if this principle be assumed, it may safely be stated, that the entire phenomena are repugnant to it, unless indeed Mr. B. is an advocate for Leslie's "cold pulses showered down from the sky," and which perhaps might drive them headlong from their aerial elevation. Finally, when aboard of the Royal Adelaide, of 120 guns, in the month of July last, at Devonport, the officer on board (that ship being in ordinary) informed me, that he was annoyed with small spiders alighting on the ship with a dry easterly wind.

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* Second edition of my " Experimental Researches in Natural History."

CHAP. VII.

UNEQUAL DISTRIBUTION OF TEMPERATURE—THE METEOROLOGICAL FEATURES OF THE CLOUDS DEPENDENT ON THEIR ELECTRIC CHARACTER—DEW—RAIN—HAIL.

DESSAIGNES has shown that heat modifies the kind and quantity of electricity, that electricity is excited whenever any body is unequally heated, and it may thus be considered that an unequal distribution of heat and moisture in the atmosphere will determine the evolution of the thunder storm: we were much surprised at the very rapid change of temperature which took place during a thunder storm near the Rhine, observed in 1825; the extreme limits of this vibration of temperature amounted to nearly 14° F. and the oscillations were exceedingly abrupt: the curious configurations of the clouds, and all their numerous ramifications and modifications owe their being and change to electric power and influence. Mr. Howse, a very extensive traveller in the regions of North America, and among the Esquimaux tribes, and whose "hut" is laid down in Arrowsmith's map, mentioned to me a very extraordinary phenomenon he witnessed in the atmosphere about latitude 57° : the entire atmosphere seemed like *eddies* and *circles* in constant motion, widening and falling into each other, and beautifully coloured *green* and *red*, &c.: this continued for many hours, and was observed by another individual at the same time, though nearly 150 miles distant. Clouds are understood to be visible aggregations of minute aqueous particles held in suspension in the atmosphere, and such may cease to be visible from their extreme attenuation or diffusion, or may melt away into the atmosphere, being dissolved, or their destruction may be effected by resolution into rain. We are indebted to Mr. Howard for an arrangement and classification of the clouds; they are comprehended under the general terms, *cirrus*, *cumulus*, and *stratus*; these occasionally combine or mix together and produce intermediates, as *cirro-cumulus* and *cirro-stratus*; there is also the *cumulo-stratus*, and a combination of the entire three, the *cirro-cumulo-stratus*, *nimbus*, or rain cloud. Generally speaking, the three simple forms of cloud are suspended at different degrees of elevation in the order in which they are placed, the *cirrus* being highest, and the *stratus* lowest; the latter appears generally reposing on the verge of the horizon: the cirrus has been called the *proteus* of the skies, from its frequent and rapid changes; it is the first cloud seen in clear weather: sometimes pencilled and thready or fibrous, and ofttimes the end resembles a brush; this form of the cloud may be considered as at antipodes with the *nimbus* or storm cloud, and dry weather, easterly winds, and luminous meteors, or shooting stars, are its usual attendants: the *cumulus* is exhibited as it were in flocculi or fleeces; or patches, acting occasionally as skreens to intercept the sunbeams: before rain they increase rapidly, and descend to a lower plane in the atmosphere; in some cases they present hemispherical masses, like alpine ranges with fleecy summits; are occasionally seen to evaporate as soon as formed, or an aggregation is formed by numbers of these coalescing: these modifications and inosculations are doubtless the effects of an electric change: when the cirrus and cumulus together form the *cirro-cumulus*, they present what Bloomfield has very elegantly compared to

> "The beauteous semblance of a flock at rest."

The *stratus*, agreeable to what has been stated, is the lowest of the clouds; it rests on the plane of the horizon, or settles on the earth or water; it has been called *the cloud of night*, ascending into the atmosphere in the morning, and sinking at night. The dense fogs of autumn and winter are referable to the *stratus* or its modification; hence also *mist*, which is the same thing, and which so often shrouds the mountain traveller: the fine mists which creep or steal along the valleys in a summer's evening are generally white, and have a beautiful and interesting appearance when silvered by the moon beams: when the sky is mottled with *cirro-stratus* it occasionally gives rise to what has been called the "mackarel backed sky:" in the evening and morning it is often painted with beautiful colours,—the occasional canvass of the most brilliant and vivid tints: different shades of purple, crimson, lake, and scarlet, these are the most prevalent colours: the horizontal sun, accompanied by haze, indeed refracts different colours at different times: but yellow, orange, a golden hue, red and lake are those most commonly observed. The *cumulo-stratus* varies in appearance; sometimes it seems like a *cauliflower* or a vast mushroom, and at other times resembles a range of mountains silvered with snow: before thunder-storms the *cumulo-stratus* becomes reddish. The *nimbus* or storm cloud is thus described by Mr. Forster:—"In stormy weather, *cumuli* may be seen rising into mountains, and becoming *cumulo-strati*, while long strata of *cirro-stratus* permeate their summits, and the whole phenomenon has the appearance of a range of mountains transfixed by the mighty shafts of Giants: after having existed some while in this form, they become large and irregular, and they get darker by intensity, till they seem concentrated in a dense black mass, with a cirrose crown extending from the top, and ragged cumuli entering from below; and eventually the whole resolves itself into rain."* The *stratus* form of cloud is found to be highly charged with *positive* electricity, and the anastomosis and coalescence of the several varieties of the cloud, with their condensation and final resolution into rain, are all so many modifications and states of intensity in their electricity, which, when concentrated in the storm cloud, at length pours down its destructive elements: the *stratus* has been seen hovering over the surface of lakes, as at Windermere, &c. and being attracted by the mountains, has discharged its electricity against their sides, like an electrical battery. Mr. Glover, the celebrated landscape painter, informed me that he had often seen this.

In Dr. Well's theory of *dew* we are supplied with an elegant solution of the problem of its formation and preceding cause: the whole phenomenon is dependent on radiation: a *still* atmosphere and a *clear nocturnal* sky are necessary conditions; the heat radiating from bodies on the terrestrial surface, reduces their temperature below that of the atmosphere in contact with them; the consequence is a precipitation of moisture on their surface, or in other words *dew* is formed, and those objects become first bedewed that are superior conductors of heat, hence bars of silver and copper would sooner be bedewed than those of gold or platinum: it depends, therefore, precisely on the same principle which produces the deposition of dew on the exterior surface of a glass vessel remaining in a warm room, when water brought immediately from the pump well is poured into it. Rain is formed of condensed aqueous particles precipitated from the *nimbus*, and will be more or less violent, or more or less dense in respect to the drops that fall, according to the intensity of the electricity which invests the cloud: for the electricity, when concentrated to a vast amount, will finally burst its envelope, and in its descent will carry with it the watery contents of the cloud, and in proportion to the accumulation of electricity, and the greater or less sudden rupture of the cloud, will be the violence of the precipitation: the rain which falls has been frequently found electrical, sometimes positively, and at other times negatively. Snow is congealed aqueous vapour, and occasionally exhibits elegant and varied configurations. In the Edinburgh Philosophical Journal, we have an account of a shower of luminous snow, by the Rev. Colin Smith:—towards the end of March, 1818, a party of gentlemen were returning homewards from Ben Cruachan, in Argyleshire, when in crossing the lake, (*Lochawe,*) in a boat, they were overtaken by a singular snow storm: the lake, which was of glassy smoothness, with their boat, clothes, and all around, presented a luminous surface, forming one huge sheet of fire; nor were the exposed parts of their bodies singular in this respect, for to the eye they all seemed to burn, although without any feeling of warmth: when they applied their hands to any of the melting snow, the luminous substance adhered to them, as well as the moisture, and this property was not lost by the snow for twelve or fifteen minutes: the phenomenon was doubtless electric. Hail may be considered as congealed drops of rain, generally rounded, containing opaque nuclei, the exterior layers or shells of the hailstone being more or less transparent; sometimes they are of very considerable size, or rather are fragments of ice of several inches in diameter;* of this description are the hail storms that occur in France, Switzerland, and Italy, and do such extensive mischief to corn fields and vineyards: these precipitations of ice arc attended with thunder and lightning, and seem the contents and immediate production of the storm cloud; and though in this country such fatal storms are *comparatively* rare, and their destruction limited, still the amount of damage sustained annually in Great Britain is very considerable, Such take place during summer, or in autumn, and when the atmosphere is in a state of intense electricity; they are therefore partial and local, and necessarily confined to those aggregations of electricity in the atmosphere which have been referred to; and as the storm cloud is comparatively limited, and floating in a particular direction, it pours down in its track the elements of unsparing desolation. Now it will be found that some particular circumstances determine this discharge of its tempestuous contents,—a chain or ridge of imperfect conductors, such as the summits of hills, or the salient angles and fragmented masses of rock; and when once the integrity of the storm cloud is broken, its progress in the heavens is marked by a line of ruin on the surface of the earth. A few years ago, a farmer in Lincolnshire lost to the amount of many hundred pounds by a hail storm, accompanied by thunder and lightning, and the extent of damage done to the glass of hothouses was immense. On the 1st November, 1826, a hail storm occurred in the immediate neighbourhood of Wolverhampton, by which one gentleman alone lost, by the pelting of the pitiless storm, glass in his hot-houses to the amount of £150: a sea-gull seemed to have got entangled in the vortex of this storm, and fell almost lifeless at the adjoining toll bar, where it was taken up. But on the Continent these visitations are dreadful: in a few minutes vineyards and corn fields are left in a state of the most complete denudation, and we have witnessed near to Verona, a field of Indian corn so completely devastated, that it appeared as if levelled by the mower's scythe. The most remarkable visitation of this description in our own country, in modern times at least, was that which occurred on the 2d May, 1811, in the vicinity of Shrewsbury; and as it is, as far as we know, without a parallel in the history of this clime, we make no apology for presenting an account of it drawn from authentic sources: it reminds us very much of the scene of devastation which we witnessed in the *Valais*, in 1818, by the bursting of the barrier of ice that pent up an assemblage of waters fed by the torrent which flowed from the Glacier of Gietroz, and which had formed a lake two hundred feet in depth.

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* Researches about Atmospheric Phenomena, 8vo. 1815 London, 2d Edition, p. 26.

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* We were informed that a gentleman some time ago picked up fragments of ice which fell during a thunder storm, in Derbyshire, measuring five inches in diameter, and others were stated to have been found that measured six inches in diameter, being a circumference of one half yard.

The catastrophe of 1811 was assigned to the "bursting of a cloud," and the following is an extract from the letter of a friend, personally conversant with the facts :—" It took place on the Stipperstone-Hill, about five o'clock, P.M. in the month of May. The appearances preceding the phenomenon were a hazy atmosphere, a stillness in the air, and an oppressive heat in the lower regions, although the hills were immediately after covered over with hail; and at Pontesbury, a village about a mile distant from the spot, the hail lay a foot deep, and most of the stones measured two inches in circumference; the storm was accompanied with vivid flashes of lightning and loud thunder. The great body of water divided before it reached the village of Minsterley; but at Pontesbury, it was twenty feet deep, it caused the river and brooks to overflow, almost instantaneously, their banks, and extended for miles over the adjoining country; the damage occasioned by this calamitous event amounted in the aggregate to £15,000, and fifteen individuals perished. About the time of the catastrophe it was evident that the air was highly charged with electricity, and the cause was generally attributed to the condensation of the skirts of an immense cloud by the rugged points of the hill with which it came in contact. The storm passed off in the direction of Worcester, and came on there with a tremendous fall of hail, or rather fragments of ice, measuring 5 or 6 inches in circumference, its course being marked with complete desolation. The Severn rose in one hour

6 feet, and continued to rise to the height of 20 feet; the storm here was also accompanied with torrents of rain, continued peals of thunder and vivid flashes of lightning." We are informed that the hail storm did great damage at Worcester, and that the windows of the town-hall were battered to fragments. The following is a somewhat more detailed account of the dread event, extracted from the Shrewsbury Chronicle, and merits a more permanent record:—"On Monday afternoon, a violent storm of hail, thunder, and lightning, was widely felt, particularly SW. of the town of Shrewsbury. The air was sultry, the lightning very vivid, and the thunder is described by persons near Minsterley to have been similar to the report of many cannon immediately over their heads; near the White Grit, hailstones two inches in circumference lay almost a foot deep. About five o'clock P. M. a cloud burst upon the ridge of hills, called the Stipperstones, and a torrent of water with irresistible force and thundering sound rushing down the hill side, swept away several small cottages belonging to the White Grit miners. Part of the vast body of water took a direction through Habberly, but the greatest quantity pursued its course along the valley, through which runs Minsterley brook. From the vicinity of Mr. Nailor's, of Hoxton Mills, buildings and every thing in its way were overwhelmed; and our readers may

form some idea of the bulk and impetuosity of the torrent, when they are told, that, among others which it tore up by the roots, one tree, containing about eighty feet of timber, was floated over meadows more than a mile.

" Between five and six o'clock the deluge reached Minsterley, flooding almost every house in the village. Mr. Vaughan, a farmer, was swept away from his fold, and carried several hundred yards through the bridge, where the current threw him upon a pigsty, from whence he climbed to the roof of a house, and was saved: his sister was carried to a great distance, and left in the branches of a tree, but so much bruised that she is not expected to survive; not a trace is left of his thrashing machine or stabling, but three horses escaped. Thirteen persons were miraculously saved in the Angel public-house: on the first alarm they ran up stairs, and when the water had reached the second story they clung to the rafters. The stabling, with all other contiguous buildings, were swept away: in the stables were seventeen horses, and they swam out. The stables of the Rev. Mr. Williams, and part of the church wall, are also carried away: three persons perished in this village.

" The next scene of desolation was Pontesford, where it is enough to mention its ravages only at one spot: at Mr. Heighway's it burst into the house through the windows, till at length the walls gave way, and Mr. Heighway's venerable grandmother, aged 83, with two female servants, and a labourer, were hurried into the abyss: meanwhile Mr. Heighway's wife and another lady climbed upon the roof of the house, from whence they beheld Mr. Heighway cling to a pole, who was lifted by two men upon the bridge, about thirty yards distance. Mr. Bennet, an overseer of Pontesbury coal works, and two others, got into a hay loft, where, deeming themselves secure, they were in the act of petitioning the Almighty to deliver the persons upon the bridge, part of which had just fallen in, when instantly the building was swept away, and the unfortunate men were all lost: the bodies of these men were not found yesterday. The loss of Mr. Heighway, it is supposed, will exceed £4,000, and nearly the whole of his house, except the end in which his wife and her companion were saved, is destroyed; together with the furniture, stabling, barns, sheds, two valuable horses, tan pits, hides, bark, &c. and every tree is torn away from his orchard: at this place the water was at least twenty feet deep.

" At Minsterley, the water was from six to eight feet deep in some houses. The house and mill at Platt's green were carried away.

" At Hanwood the damage done in the linen mills of Marshall, Atkinson, and Co. is considerable. The stock of flour, and the premises belonging to Mr. Blower and Mr. Pickering have sustained much injury, and, indeed, it may be said, that every bridge and mill within the course of the torrent has either been destroyed or greatly damaged. Mr. Warter's, of Cruck Meole, had one cow carried away, and Mr. Rogers another.

"The torrent following the course of Meole brook, reached Coleham, one of the suburbs of this town, about half-past ten o'clock at night, with a tremendous roaring noise. The cellars and lower rooms belonging to the Seven Stars public-house, and all the houses adjoining, were deluged; the street in front of Mr. Hulbert's factory was inundated to the depth of nearly three feet by an instantaneous gush. At this time the noise of the current was inconceivably dreadful, and the cries of 'help! help! drowning!' &c., contributed to the horror of the sound. The force of this great body of water rushing into the Severn from Meole Brook actually turned the current of the river Severn, which rose near the English bridge four feet perpendicular in ten minutes. Much damage has been done at the Abbey Mill, and in the garden contiguous. The force of the torrent running under Coleham bridge carried with it a portion of the field occupied by Mr.

Birch, by which several hundred square yards of ground will be lost to the owner.

" Ours is but a faint description of the calamity and distress which have been felt; unaccustomed as we are in this inland situation to such scenes, no imagination can picture the desolation. It is impossible to calculate the amount of property damaged and destroyed: many hundred thousands of pounds cannot recal order, and redeem the destruction to agriculture and property of every kind. We have heard it said, that, in the parishes of Pontesbury, Worthen, and Westbury, at least three thousand acres of land were deluged. The number of cottages lost has not been ascertained, and who shall tell the anguish of many a peasant, whose family is now perhaps homeless, and whose garden ground is laid desolate!" This is a description of a very terrible catastrophe, and we believe the picture is by no means overcharged. The Stipperstones is a ridge of rock, jutting out in numerous small points or edges, which, though they act on the storm cloud as so many conducting points, yet are imperfect ones without any channel to carry it to the earth: they therefore provoke the mischief, without any power to disarm it. Now, what security has that district against the repetition of the catastrophe? None whatever: it may be a very rare event, and one far distant in the records of futurity, but the circumstance may also be the event of the present season or the next, for ought, at least, that we can tell, while a double line of paragreles planted on the summit of the ridge of Stipperstones would, in all probability, we may add certainty, prevent a repetition, and save that part of the country from such a tremendous doom. The preceding account may enable us to form some estimate of the extent of the nimbus, and of the mighty deluge of waters folded up within it—the parent of those dread visitations which envelope the plain in one mighty torrent, and cause the rivers to overflow their banks, and which, in a tropical clime, during the terrible monsoon, amid the loud and appalling acclaim of the thunder, raise the waters of the Ganges, and inundate the plains of Hindostan. We have, too, been informed of an immense mass of ice, described by the natives as large as an *elephant*, which certainly fell in India: now, though we must allow a little for the figures of orientalism, it is an undoubted fact that a mass of ice, of enormous magnitude, did fall in the Mysore. Our information was derived directly from an officer of high rank, long in India, and well acquainted with oriental literature; being informed by one of the officers at the court of the Rajah, that, some years before, such an event had occurred in a village about thirty miles distant, he went thither, and satisfied himself of its truth from the independent testimony of several of the natives: it was described to be as large as an elephant, like crystal, burning their fingers when they touched it, and that in process of time it melted away. This is a phenomenon quite as difficult as the meteoric stone relative to the theory of its formation, and yet we do not believe that our earth is surrounded by a zone of such icy masses, floating in the empyreum, and can as little imagine that it came from the moon, or the lesser planets, that wheel their eccentric orbits between Mars and Jupiter, still less from beyond Uranus, the planetary boundary of our system, as far as determined by modern astronomy.

The following is an account of a continental storm, in the kingdom of Hanover, from the foreign journals:—" On the 21st June, 1828, at half-past two o'clock, Hanover was visited by a hail storm: the hail stones were as large as ducks' eggs: every pane of glass in the direction of the wind, and almost every roof, was broken in: the icy masses were in the shape of a turnip, and weighed three to four ounces each: it lasted four minutes, and it was six hours after the storm had subsided before the fragments of ice had melted. All the windows in the city and suburbs were dashed to pieces: the streets were covered with lumps of ice to the depth of a foot; the fruit beaten off the trees, and the branches broken; the birds of the air killed; all the neighbouring gardens and fields laid waste; many persons wounded; cattle killed; and the damage incalculable."

CHAPTER VIII.

DESCRIPTION OF THE THUNDER STORM——PERSONAL SECURITY IN THE STORM—EFFECTS OF LIGHTNING—PARALYSIS CURED—MAGNETISM COMMUNICATED—BENEFICENT MINISTRY OF THE THUNDER STORM.

THE *Nimbus* has already been described as the great theatre of the lightning. Before the thunder storm is announced, we shall perceive in the distant perspective horizontal lines, parallel to each other: a kind of dense vapour plane; this plane becomes still more dark and dense, arches of clouds rest upon it, the upper points even and well defined, but dark and threatning at their base: sometimes this aerial volcano seems to swell in magnitude by attracting other clouds in its vicinity, which appear to fall into it, while at other times it increases in magnitude without any such visible cause: at length the cloud is put in motion; the thunders roll and the lightnings flash, and the rains descend, till, having spent its materials, the Nimbus separates into fragments, which melt away in the aerial abyss, and discover to us a serene sky. The reverberation of the thunder is attributable to the irregular surfaces of surrounding objects, and by means of these the sound is echoed, and sometimes often repeated : at sea, from the absence of any such surfaces reflecting sound, it is, of necessity, more regular, decreasing in its intensity, and finally dying away on the ear. The succession of sounds, therefore, presupposes the existence of bodies susceptible of reverberating the sound, and the loudness and duration will vary with the situation, distance, and nature of the reflecting surfaces, without any relation to the interval of time between the peals : the same thing is observable in a piece of artillery when the discharge is made : when the sound immediately succeeds the flash, a single explosive report of peculiar sound, or *crash*, is heard, and in this case the discharge has occurred not far from the observer; the *distance* of the storm may be easily calculated by observing the number of seconds in the interval between the flash and sound : lightning takes up a very limited period of time in its circuit, but sound moves at the rate of 1142 feet in a second of time ; thus, the number of feet multiplied by the seconds of lapse, would inform us of the distance, were the flash of lightning instantaneous like that of light; but this is not exactly the case, and it would only be the measure of danger as to the source of lightning in the discharge that has *already* taken place; but the focal cloud is still moving, ever changing its position, and even occasionally appears to be capricious: sometimes we have thunder storms recorded as occurring simultaneously in distant parts of the country, which would seem to indicate the electrified state of an extensive region of atmosphere. The lightning may be elicited from the atmosphere by the electric discharge, and the sound be the concussion produced by the recession of the elastic shells of air, and their violent return to fill up the void occasioned by the explosive force. There seem to be two distinct kinds of lightning,—a vivid flash followed immediately after by loud thunder like the sound proceeding from the discharge of cannon, and this is the most dangerous kind: the other has more extent of light, and is preceded by rolling thunder, and we have seen both alternate in the same storm. There is a difference not only in the intensity or vividness of the flash, but in the colour, sometimes it is bright, and at other times bluish; and we remember one night at Sion, in the Valais, that successive gleams of blue lightning were almost constantly discharged during the whole night, the intervals being scarce appreciable. The most powerful lightning is that which assumes the zig zag form, called "forked lightning," which while it shows a considerable concentration, exhibits also the powerful resistance opposed to its progress by the atmospheric air. The sheet, or silent lightning, is the quiet discharge from cloud to cloud, or the reflection of the lightning from the bosom of the cloud, which conceals the concentrated point of discharge, and the non-accompaniment of sound may be ascribed to the great altitude at which it takes place: and such certainly occurs in weather when the clouds may be supposed to have attained a considerable elevation. The most curious part of their history is, that they are always seen in the horizon, and lovely indeed are the coruscations which blaze on the cloud capt summits of the Alps: the flashes are brightest when defined clouds make their appearance. The greater part of flashes of lightning are discharged from one cloud to another, having an opposite electricity, and the instances are comparatively rare when the electric fire strikes terrestrial surfaces: in the last case it depends on a vast accumulation of power necessary to overcome the *striking distance*, as it is termed by the Electrician, and its effects are proportional to the conducting character of the medium, and the concentration of the mass, in other words, to the resistance it meets with in its vivid progress to the earth, and to the difficulties or facilities presented to its final escape into the earth. A fine copper wire may safely conduct it, while an iron wire might be dispersed into vapour, and if the former were a mere thread of wire, it too might be melted by the torrent of accumulated electricity. Occasionally the lightning ascends from the earth to the heavens; we have only once witnessed a decided instance of this description, but so palpable that we could not be mistaken: the ascending lightning moved in a *spiral* form. In truth there are peculiar phenomena on record which seem otherwise inexplicable, such as the transport of a mass of brick work lifted bodily upwards, and carried to a distance:—these may be connected with what has been called the *returning stroke.* In order to illustrate this, we may suppose an arch of electric cloud in the sky extending over a considerable surface; if the lightning be discharged at one extremity of the arch, against some terrestrial surface, an electric ascent would simultaneously take place from the earth to the other extremity of the arch, in order to restore the equilibrium; this last is called the "returning stroke." The following interesting fact was communicated to us by the Rev. Mr. —: during a thunder storm in 1826, a tree at Acton, near Wrexham, the seat of Sir Foster Cunliffe, Baronet, was struck by lightning and shivered to splinters; two of the children of the Rev. gentleman in question, with their nurse, were walking at the moment, at some distance from the field where it happened; one of these children was in the nurse's arms, while the other walked by her side: when the crash supervened, all were *suddenly lifted up about two feet above the earth,* and as suddenly let down again without the least harm. This may certainly be adduced as an interesting illustration of the returning stroke: we also received another well attested fact of an ascent of lightning from the earth to the sky, in which several gentlemen were engaged in conversation during a thunder storm, in the open street, when the lightning visibly rose from before them and ascended. The thunder cloud is occasionally at no great elevation above the earth's surface: from the summit of some elevated mountain the traveller has often seen the lightnings play, and heard the thunders roll beneath the battlements of the rock:—Massena and Souwarrow were engaged in battle on the St. Gothard, above the region of the storm, while the lightnings flashed and the thunders rolled far beneath them: but in these high latitudes of ours, we can form only a faint picture of the terrible sublimity of the storms of tropical climes,—truly terrible indeed are the lightnings which, in the monsoon and tornado, illuminate the sky and its sable canopy, and sublime and beautiful are the electric flashes that gild with their reflected corruscations a Mont Blanc, and a Chimborago.

With respect to protection in the storm, it may be remarked, that when exposed in the open country, we must avoid seeking shelter under a tree, or by the wall of any building, and agreeable to the numerous observations we have made, such trees as are insulated, or stand apart; for instance, those in the middle of a field are more likely to be struck by the lightning than such as form part of the group of a clump or forest ; streamlets, rivers, ponds, or other collections of water, are dangerous and may determine the lightning, which would find a superior conductor in the vertical human frame, and its circulating fluids; we must therefore retire from their banks : if the crash succeed the lightning with no sensible interval of time, we are exposed to the most imminent and immediate danger, and our obvious and best security is to throw ourselves down upon the ground, and maintain that horizontal position : being thoroughly wet will add to our safety, and if we can count from eighteen to twenty between the flash and succeeding peal, we are tolerably secure. It has been calculated that electricity moves with a velocity more retarded than light, and its movement estimated at 1950 feet in a second of time; this being the case, we must deduct the rapidity of sound per second, from the sum in question, which is 1142 feet; the remainder multiplied by the number of seconds between the flash and the peal will determine the distance from the observer:—let us suppose the interval is five seconds; then $1950-1142=808\times 5=4040$ feet distance: the noise of the thunder is an announcement that the danger is over. The umbrella should never be used in a thunder-storm: when in the house we must not approach the fire-place, for the chimney lined with carbonaceous matter forms a tolerably good conductor; last season a cottager was reading by the fire, the poker was inclined on the grate, and a dog was sleeping in contact with it; the dog alone was killed by the lightning that decended by the chimney, and was conducted to the earth by the poker, while the man escaped, having received only an electric shock; in like manner the bell-pull must be avoided *if attached by metallic wire*,* for the lightning has frequently entered a house, pervaded the bell wire, and finding no escape to the earth, has exploded here, burst through the window, and shattered a tree in the garden: in like manner all metallic objects whatever are to be diligently and studiously avoided—even gilded mirrors and picture frames: we have lately been astonished to remark, in an instance where the lightning entered a building, the very extraordinary avidity with which it seemed to have run about, as it were in quest of some medium of escape from the premises; the very nails in the floor were attacked, as well as those which had attached the laths to the ceiling and partition, the hinge of the door, and even a nail which attached the head of a spade to its shaft was wrenched out, and imbedded in the wall: it appeared, indeed, to have ramified like "*wild fire*," and attacked every thing in the shape of metallic matter, with a fierceness quite surprising. Every thing metallic must, therefore, be discarded: females should even lay aside their usual work, as their needles and scissors might operate as attracting points: in one instance, we were informed, while a gentleman was playing on the flute, at a window, the silver key of the instrument attracting the lightning, the instrument was struck to the ground: and while the silvered mirror has been displaced from its frame, and found unfractured on the table, the frame has been shattered to fragments: in a house not protected by conducting rods, gilt mirrors, picture-frames and mouldings, gold and silver paper hangings, and bell wires, with the furniture of the fire-place, are all principal objects in the lists of danger. Last season, a female was killed by lightning when about to enter the *corfe* attached to the shaft of a coal-pit in Staffordshire, and the shoe-leather was torn into fibrous strips, caused, apparently, by the numerous nails therein. The centre of the room, and the middle story of the house are the safest points: to recline either on the sofa, or on the bed is advisable, and these are the most secure places; for, besides the horizontality of the position, the insulation is so complete as to supply all the requisites of security stipulated by the laws which regulate electrical phenomena: it is absurd to take refuge in the cellar as some timid persons have done, for the lightning *may ascend*, and there are instances on record where the lower story has suffered, and the superstructure been safe. A medical gentleman told me that he once went into his cellar during a thunder storm, and was in the act of drawing off beer from a cask, when he received a very violent shock.

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* In modern furniture this is happily obviated.

The effects of lightning are very terrible; the agent is resistless; the proudest monuments of human genius are in a moment levelled to the ground, or shattered to their base, hymadryad of the woods,—the patriarch oak, shivered to splinters, and the alpine rock rent into fragments, and hurled from its eagle eminence into the valley beneath. And yet this dread agent has a "still small voice" which bids the fluids rise and flow in animal and vegetable being, and enables the little aeronautic spider, suspended by his silken parachute, to ascend to the regions of the clouds: this too is the agent which, artificially applied, has made even *the dumb to speak*, as attested by Mr.

Miles Partington,* and under the form of a flash of lightning, cured a helpless cripple, as we find by referring to the case in the London Medical Journal:—a person of the name of Terry, *blind* for some years, in crossing one of the London bridges, during a thunder storm, in the summer of 1828, was struck down by a flash of lightning, and this singular misfortune appears providentially to have restored the sense of vision. We have a recent remarkable instance allied to these cases, in that of the *New York* ship bound from London to New York; this vessel was twice struck by lightning—the second stroke effected a very extraordinary cure, of which the following are the particulars:—"A passenger very old, was so much palsied in his limbs that for three years he had never been able to walk above half a mile, and after his embarkation had never been seen to stand up for a single instant: however, soon after the second discharge of electric fluid, which took place near to where the poor invalid was lying, he was observed with astonishment, parading the deck, which he continued to do for some time, as if he never had been ill: at first he lost his senses, but this did not continue long, and the cure was complete; he walked with ease all the rest of the voyage, had the entire use of his limbs when the vessel arrived at New York, and travelled on foot thence to his own residence."

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* See Brande's Journal, vol. 16. p. 187.

Not the least remarkable effect of lightning is the communication of *magnetism* to iron or steel: in this very account we have a similar fact stated, for some of the knives and forks in the ship were partially fused, and had acquired magnetic powers. The effect produced on the magnetic needles was very remarkable, for although they were all in the same room, the results were diversified; in some the magnetic action was augmented, in others it was diminished; in some it was destroyed, and in others the poles were reversed: and we also find in reference to the latter circumstance, that by a stroke of lightning the magnetic poles in Captain Waddell's compass, as related by Dr. Franklin, were reversed. In the Transactions of the Royal Society, No. 157, p. 520, and No. 237, p. 57, is the following fact on record:—a stroke of lightning passing through a box of knives communicated to them powerful magnetism; and Mr. Walker in his Treatise on Magnetism, p. 10, mentions a fact similar in kind:—"In the Island of Jamaica, in the month of September, 1792, one end of my house was shattered to pieces by lightning, which killed one young woman, and very much hurt another; in a part of the house that had received but little damage, a girl who at that time had stood close to the one that had been killed, took out her needles soon after; the needles stuck all together in her hand so strongly, that she took the point of her scissors to separate them, and so powerfully were they and the scissors magnetised that part of the needles stuck to them in different directions, and they lifted up the remainder like a thread, each needle hanging by the end of another." We have also an account of the magnetic effect of lightning in the *Annales de Chimie*: it occurred on the 22d June, 1822, at Toulouse; "a tailor was sitting in a chair, near the conductor through which the lightning passed; he felt no shock; but next day, on taking a case of needles from his pocket, he found them so strongly magnetised, that they hung in groups of six or seven together: another case containing five needles was lying on a chimney piece, 20 feet from the conductor, and these were also magnetised." While the interesting science of electro-magnetism reveals to us the principles of these singular results, they will teach us the necessity of disposing of every thing of a metallic kind from our persons, and make us cautious in handling them.* We have heard of a flash of lightning having struck knives and forks laid out in a dinner service on the table, and the lightning was seen to sparkle among them like the phenomena of the Diamond jar, or that of a metallic chain when the electric discharge is passed through it.

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* The death of individuals may not unfrequently have been determined by some such simple and unsuspected cause.

Truly important are the advantages subserved by the thunder storm, nor can we venture to calculate their amount: two, however, are more obvious than the rest: when there is an unequal distribution of heat, its beneficent ministry tends to equalize the temperature, and restore that lost healthy equilibrium, which is so important a desideratum to the economy of animal and vegetable life: and as there can be no doubt that a portion of *nitrous acid gas* must be formed in every thunder storm by a reversal of the chemical constituents of atmospheric air, as was found in an experiment of the Hon. Henry Cavendish, (who by passing a series of electric sparks through a confined portion of this medium, obtained evident traces of the production of nitrous acid vapour,) and as nitrous acid gas is a most powerful disinfectant, the thunder storm will thus tend to destroy the noxious and deadly miasmata that ascend from the surface of the ground, or are diffused through the air. Vegetation, after the thunder storm, seems to wear a more healthy glow and lovelier livery, and the animal frame feels more elastic, and braced, and lively; when the seeds of disease are floating on the bosom of the atmosphere, these germs of morbid nature are decomposed and destroyed: and when the frame of the atmosphere is disordered, it is restored again and renovated, its sickness is healed, and it beats a healthier tone than before.

CHAPTER IX.

THUNDER RODS—THEIR ATTACHMENT TO BUILDINGS, AND TO SHIPS AT SEA—THE PARAGRELÆ—INFLUENCE ON THE STORM CLOUD—EXTENSIVE UTILITY—CHANGE OF CLIMATE.

THUNDER or lightning rods are metallic bars attached to buildings for the purpose of presenting a medium of escape to the lightning; which, when it strikes a building, seizes on the best conducting medium, and most direct passage to the earth, and if these are not provided for it, its vengeance is terrible, and will be felt. The question whether *balls* or *points* should terminate the conductor, was once stoutly contested: points, it was contended, attract the lightning from a greater distance, and, as it were, invite the approach of the storm cloud, which might otherwise pass by on the other side, or at least float over the spot harmlessly: but it was overlooked, or forgotten, that lightning exercises terrible powers on a blunted surface such as a ball, from the great difficulty opposed to its entrance by the resistance it finds under such circumstances, facts known to every electrician, while there is no such difficulty of entrance or exit with respect to a point; the difference between the two is beautifully illustrated in the approach of a ball and a point, at the same distance from the conductor of an electrical machine in motion; an explosive spark passes to the ball, whereas the point draws off the electricity silently and imperceptibly, thus proving the superiority of the point: and as to its acting at a greater distance on the storm cloud, this is an immense advantage, because it need not be *so long* as the one with a ball at its summit, to produce the same effect, and if the influence of conductors as to the surrounding objects be double (as has been stated) its length or altitude, it is evident that the circle of the power of a pointed conductor must be less circumscribed than one with a blunted surface. We must not only provide the best medium as to conduction, for the passage of the lightning, but also afford facilities for its entrance and exit, all which in our apprehension seem to have been overlooked in the construction of conductors in this country. There is no evidence whatever of a point attracting the storm cloud out of its prescribed path; but there is evidence of such a cloud momentarily halting at the *out posts*, as it were, of a phalanx of paragrêles, there parting asunder, the one portion filing off to the right, and the other to the left of the paragreles. The gunpowder magazine, at Purfleet, though supplied with two pointed conductors, was struck by lightning, in 1778: and there are also instances of two houses in this country having been similarly visited, though furnished with conductors*; but more than nine-tenths of the conductors attached to buildings in Great Britain are worse than useless, nay act a false character, and tend to invite destruction on the buildings they are meant to protect and defend. Such conductors are always formed of *iron*, a very inferior conducting material, and worse than all, they are mostly corroded through with rust, the consequence of oxidation; now metallic oxydes are not conductors, and since it appears clear from the experiments of Coloumb and Biot, that electricity penetrates the surface to an *inappreciable depth*, its conducting character by such superficial oxidation is utterly destroyed, while the point may still operate partially and imperfectly as a *point*. Besides, we shall find these conductors, as they are called, often dislocated, sometimes linked together, and at other times fastened to the wall by iron clamps or staples, and finally, instead of entering the earth, the extremities are left to dangle several feet above the surface, as if we wished the lightning to raze the building from the foundation. Iron is every way objectionable as the *material* for a conducting rod, or to form any part of it, and we exceedingly doubt the propriety, notwithstanding the high authority of M. Gay Lussac's opinion, of having the conductor formed of two pieces, and those *different* metals; and above all, from the circumstances already stated, of having one of these pieces *iron*: we are still more surprised at the recommendation of fifteen *iron* wires being twisted together to form a "strand," and in order to prevent its *rusting*, each wire is to be well tarred separately, and when they are twisted together, the whole rope thus formed is to be tarred again: now the resinous composition tar, is an electric or non-conductor, and the (superficial) conducting portion of the metallic rope is hereby made useless. When lightning has traversed the interior of a building by means of a bell wire, and that wire has been occasionally fused and left its impression on the plaster surface of the wall, such wire, we believe, will be found always to have been *iron*: the iron conductor attached to the *New York* already alluded to, and which is stated to have been three-tenths of an inch in diameter, was fused throughout, and fell in melted drops into the sea. Dr. Fischer, as stated in the *Bulletin Universel*, mentions the case of an *iron* conductor attached to a powder magazine, having entirely failed on several occasions in preventing the explosion of lightning close by its side: he ascribes this to its having acquired magnetism—he found it magnetic! and we would ask is an iron conductor ever found otherwise? certainly not. He asserts from his experiments that iron when magnetized loses much of its conducting power for electricity: an individual of the name of Abraham, of Sheffield, states on the contrary, that the conducting property of iron is *increased* by being rendered magnetic:—"Non nobis tantas componere lites"—but we are astonished at the recommendation of the latter, to have all lightning rods of *magnetised iron*, as if it were not a matter of notoriety that every rod of iron *the moment it is raised to the vertical plane*, acquires an instantaneous magnetic power,—independent altogether of that which it would at *any rate acquire* by the *stream of atmospherical electricity constantly passing through it*:—hence Sir H. Davy's recommendation of the communication of magnetism to steel bars, by attaching them to lightning rods.

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* All these were of *iron*.

The conductor of a building should be of *copper* annealed or softened, and finely pointed at the extremity; the stem may be half an inch thick, and its summit rise several feet above the highest part of the building to which it is affixed: the conductor should be attached to the building by being threaded through wedges of baked wood, and when within a few feet of the surface of the ground glance off at an angle, and finally terminate in a well, tank, or some wet place beneath. M. Gay Lussac proposes to elevate the conductor fifteen to thirty feet above the building; we confess we do not see any such necessity, for though the experiments of Messrs. Romas and Charles go to prove that the efficacy of a conductor will be increased in the ratio of its elevation, it must not be forgotten that the *resistance of a conductor increases with its length*, and therefore, we think it decidedly better to use *two* instead of one where the extent of building requires it, and not to have the conductor longer than necessary: as to those conductors which terminate in several spikes at all angles with the horizon, and those crowned with balls, surmounted with points "like quills upon the fretful porcupine," as in the Botanic Garden at Liverpool, we doubt their propriety, though if they were attached to *separate stems* we should advocate their utility: the following seem requisite conditions in a good conductor: 1. A finely pointed summit to offer an unresisting entrance. 2. A sufficient length to anticipate, as it were, the descending electricity, and receive it on its summit before it could reach any part of the building. 3. A superior conducting power in the material of the rod to facilitate its passage to the earth. 4. A sufficient thickness to prevent its fusion, which we think, however, will greatly depend on the resistance it has encountered in entering the conductor, and finally, a safe conduction to a well or moist surface below ground. As remote parts of extensive buildings have been struck by lightning at distances three or four times the length of the conductor, it is evident that its power is *circumscribed* in its influence, as may easily be believed, and experiment seems to prove that this influence *extends to a radius double the length* of the lightning rod; that is to say, the influence of a good conductor attached to a tower 120 feet high, will extend to a distance all around of 240 feet. While we should much prefer the conductor being attached to an insulated rod, altogether separated from the building it is intended to defend, we, at the same time, require that there should, in *all* cases, be more than one conductor, and in many instances, as in gunpowder magazines, the space hedged in by several: flanked by such a circumvallation, like the city defended by the redoubt or the bastion, an ample security would be provided against the attacks of the storm—in the case of paragrêles, however, a more multiplied array would enhance their safety, and it would be better to guard doubly the avenues of danger, than by diminishing the number of sentinels to incur even a *possibility* of risk,—a *perfect and absolute security is certainly attainable*: we do not think it necessary to enter more at length into Mons. Gay Lussac's views of conductors, as they differ in many respects from our own, as may be inferred from preceding observations, and they are not materially different from those we examined in 1825, as attached to the two extremities of the *Maison de Force* at Lausanne; the conductor here was iron, with a gold summit: it entered the earth through a trough or box filled *with charcoal, to prevent at this part* the rusting of the iron, and finally landed in a well under ground.

The conductor we are about to recommend is composed of four softened copper wires, formed into a fasciculus by copper rings, these wires are separated at top, and bent from the centre outwards, at about an angle of 45° with the horizon, they are elevated several feet above the highest part of the building, and are threaded through wedges of wood: at about two feet from the surface of the ground they glance off at an angle, and terminate below the surface in the moist subsoil: the wires should diverge here, to allow the more ready diffusion and form an escape for the lightning: this may be called the *root* of the conductor. The following plan, we think, will completely obviate the necessity of having a gilded summit, and may be conceived an interesting application of the principle of voltaic electricity:—Let the wires below ground in contact with moisture pass through a *cylinder of zinc*, before they diverge to form the root, the copper wires will in this case always remain free from any oxidation. The diameter of each wire we recommend to be one-fifth of an inch, which would give a circumference of three-fifths to each wire, and an aggregate conducting superficies of two and two-fifths inches. In this arrangement we have four points, and each point its respective stem: a pointed conductor only acts as *one point*, irrespective entirely of the size of its stem, while multiplied points act in the ratio of their numbers. The tower of a church might be supplied with two such fasciculi diagonally, or at opposing angles; if the tower be 120 feet high, we calculate the expense of each at about £6. 6s: the influence of a conductor at this elevation would extend to a distance of 240 feet in every direction, and if there are two of this length, the distance apart and secure might be 480 feet. We doubt the propriety of connecting any of the metallic appendages of the roof to such conductors, as from their superior altitude and eminent character as conducting media, such would be superfluous, and might distract the lightning in its progress. One of such conductors attached to a vessel with a single mast will be found a sufficient protection; but in the case of a ship, there should be one attached to the main and another to the mizen mast; and from their flexibility, their fixation, it is presumed, would not interfere with the operations of the ship: we would further recommend that the united wires pass through a wooden cylinder, glazed inside with shell lac, and inlaid in the deck: the extremity of the wires being brought at length in contact with the copper sheathing. It has been usual to attach *metallic chains*, and these only *occasionally*, to the mast; but such are hazardous appendages, as the lightning would find considerable resistance in descending by these links, since it is known that if we pass the electric discharge through a chain, an explosion and oxidation takes place at each link of that chain. In conductors formerly attached to the masts of ships, a spindle was employed, and this connected with a chain of eyed rods, passed overboard by the deck into the sea; yet even this inefficient apparatus was erected merely on the approach of a storm. Harris's plan, certainly better, consists in attaching to the spindle, which surmounts the mast about three feet, a strip of copper, three to four inches broad, and one-eighth of an inch thick, by means of metallic nails, its entire length, finally passing through the keelstone, by a copper bolt, into the water. Lieutenant Green appears to have called in question the utility and efficacy of lightning rods altogether, but this opposition, as far as we can discover, rests on an entirely erroneous and false estimate, founded on the phenomena presented by conductors, as *they are called*, but which is a complete misnomer; the material is any thing but what it should be, while its construction is a complete violation of the known laws of electricity: moreover, the influence of the *best* conductor cannot be expected to circumscribe an *unlimited* sphere, for this were surely an unreasonable deduction, though it appears in many cases to be taken for granted. Let it be remembered that the number of *tolerable* lightning rods in the three kingdoms is extremely limited, and we have personally inspected the greater number of them. Lieutenant Green's proposition, however, we suspect will not find an echo in any one at all conversant with practical electricity: according to his plan, a spindle attached to the mast head is to be continued down to the *cross trees*, where it will "spit out" into the air!—*Valeat quantum, &c.*—Powder magazines should be supplied with a circuit of paragreles forming a double line.

The term paragrele implies that it is a safeguard from hail, as *paratonnere* signifies a protector from the thunder storm. The paragrele is intended to disarm the storm cloud of its vengeance, by withdrawing its electricity, or altering its electric character, and thus prevent the precipitation of hail stones or fragments of ice, (for they sometimes rather resemble the latter character,) and we have stated that the formation of hail is an electric phenomenon. It is even so with the thunder rod, which disarms the lightning by presenting a medium of escape to the earth: these depend on the same principles, and must necessarily stand or fall together; both may be said to destroy or to modify the structure of the storm cloud, and of course its contents are either softened down to harmless precipitations, or prevented from falling by the solution of the thus attenuated and diffused cloud, in the ambient air; for the intensity of the included electricity will have a reference to that of the lightning, which flashes from it, or to the destructive density of the rain and hail which fall. A storm cloud is the more dangerous, as its electricity is concentrated, and in proportion as this electricity is withdrawn by points, the more diffuse and attenuated it becomes, and of necessity the more harmless it is. A storm cloud may be considered a natural *Leyden jar*, or *electrical battery*.

DESCRIPTION OF THE FIGURE

FORMING THE FRONTISPIECE.

A.—A pole of wood, which may be from 35 to 50 feet long.

B.—The earth into which the pole is fixed to the depth of about 3 feet.

a.—The termination of the brass wire: it is 3 or 4 inches higher than the summit of the pole, and sharpened to a point.

b.—The brass wire attached to the pole in all its extent, resting in a shallow groove channelled in the wood: this brass wire should be about one-tenth of an inch in diameter.

c.—Small rings which fasten the wire to the pole, and prevent its displacement.

d.—A small transverse pin, which secures the conducting wire at the bottom of the pole.

e.—Thorns, brambles, or furze surrounding the pole, to secure it from injury, or prevent an incautious approach. It may be added, that the wood should be varnished to preserve it from moisture, and the better to insulate the conducting wire, while that part of the tube which enters the earth should be *charred* to prevent decay.

We calculate that each paragrele should not cost more than *five or six shillings*, and agreeable to a remark we have already made on lightning rods, and which equally applies here, they must be planted twice their length apart. If they are 35 feet long, then the distance between the paragreles should be 140 feet, allowing a radius of 70 feet *to each*, and if 50 feet long, they should be planted 200 feet apart.—Mons. Crud, of Massa Lombarda, places them even 450 feet apart, but this distance is, from our preceding observations, evidently too great, unless their length exceeded a hundred feet. Paragreles are extensively used in Italy, Switzerland, and France, to preserve vineyards and corn fields from the destructive effects of hail storms;—the opposition they have met with is gradually subsiding; hostility to their erection is rebutted by the powerful argument of their successful agency, and their erection generally extending: superstition has regarded them as opposed to the providence of beneficent heaven: —we must leave ignorance to contend with the cloud which bounds her dark horizon, and suffer her to brood over her imaginary ills, or combat the spectres that haunt her vision, rejoicing that our mind is happily of a different temperament. The storm cloud is bounded by laws and lines of demarcation, which it cannot violate or successfully contend against: the seal of the omnipotent fiat, appended to the interdict, "hitherto and no further, and here shall thy proud force be staid," cannot be broken, and the investigation of these laws may lead us to a *practical* application of the principles we discover. Prior to this happy application of scientific truth, the only method of warding off the devastation of hail storms consisted in dispersing the coming cloud by the discharge of cannon from the mountains. The following is a more questionable method of protection:—"There was a magical and superstitious use of these sweete-water-tortoyces agaynst hayle, for if a man take one of these in his right hand, and carrie it with the belly upwards round about his vineyard, and so returning in the same manner with it, and afterwards lay it upon the backe, so as it cannot turne on the belly, but remaine with the face upward, all manner of clouds should passe over that place, and never empty themselves upon that vineyard."*

It appears that paragreles were attempted in America on the principles of Dr. Franklin, in the year 1819, and with boasted success. They have passed from the new into the old world, and now prevail on the continent of Europe; in its original form it consisted of a pole surmounted with a point of brass; from its lower extremity proceeded a straw rope, with a strong linen thread twisted throughout its extent, founded on the fact, Sig. Beccaria had discovered that a linen thread would conduct electricity, and it is even used to suspend the pith balls in our Electroscopes; while Volta proved that straw was a conductor, and such is used in the Electroscope that bears his name. The figure in the frontispiece represents the Paragrele in its most improved form, and as it is now used in the Canton de Vaud, the Bolognese territories, the Lombardo-Venetian kingdom, &c. Mon. Crud has the merit of having established them in the Bolognese territory, Beltrami in Lombardy, and Professor Chavannes in the Canton de Vaud ; and we had the pleasure to discuss the merits of the question with the latter, who was gratified with the decided opinion we expressed in their favour; and which was formed from the moment we had witnessed their erection in Switzerland : Professor Chavannes had encountered great opposition and hostility. The paragrele which has been figured, and already described, is that recommended by Signor Orioli, Professor of Natural Philosophy in the University of Bologna.

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* The History of Serpents, &c. Topsell, London, folio, 1608, p. 287.

Pinnanzi, of Mantua, as early as 1788, proposed the erection of numerous metallic points in the fields, for the purpose of depriving the clouds of their electricity, and thus preventing their resolution into hail. Many sçavans entertained the proposal as exceedingly plausible, especially those of the academies of Dijon and Arras : similar opinions had been sustained by Guinard, Buissant, Morveau, Berthollet, and since that period by Bosc, and Le Normand. A few years ago, M. L'Apostolle, of Geneva, endeavoured to modify the erections proposed by Pinnanzi, by the substitution of straw ropes only ; but these were found to be insufficient, and had fallen into discredit and oblivion, when Monsieur Tollard, of the

College of Tarbes, in France, in the department of the High Pyrennees, revived them in a modified form: his plan was to erect poles of willow, poplar, pine, chesnut, &c. armed with sharpened brass points, attached to a rope formed of ripe barley, or rye straw twisted throughout, in the manner recommended by Sig. L'Apostolle, of Geneva, and contended, that he had thus succeeded in securing a territory of ten *Communes.* These interesting erections have been attacked and defended in France, Switzerland, and Italy: the *Nouvelliste Vaudois*, of August 16th. 1825, very wittily observed, "Les paragrêles n'ont que bien tenus: on les attaque partout à Paris, à Berne, à Zurich. *La grêle seule les èpargne.*" Notwithstanding, however, the opposition which the paragrêles have met with in France, we find a recognition in their favour, in a formal report presented to the government of France, by the Linnæan Society of Paris, recommending their universal adoption.*

We shall now select some examples of the phenomena they present, and their successful application. Sig. Perotti, of San Giovanni di Cassara, informs us, that having planted paragreles on an extent of 16,000 perches, he found that his corn fields and vineyards had sustained no damage, though *fourteen storms* had passed over them, and fell in full fury on the neighbouring lands of Valvasoni, Baguarola, and Savarganno. In the *Gazzetta di Bologna*, of the 17th July, 1824, we are presented with several very curious phenomena connected with paragreles, and communicated in a letter, addressed by Dr. Joseph Astolfi, to Professor Orioli. On the 19th June, 1824, a hail storm, accompanied with thunder and lightning, came from Bentivoglio, opposite Altedo, and its route was marked with devastation, but when it approached a district supplied with 50 paragreles, the storm cloud became singularly modified, a trifling quantity of hail fell about the outer line of the paragreles, but between the second and third line, it fell of the *consistency of snow*. This tempestuous cloud which arose from near Bentivoglio, moved on in another direction, and so soon as it arrived at the property of Count Chenef, protected by paragreles, *it was suddenly dissipated*, after destroying the intermediate country in its progress thither. On the 24th of June, 1824, a stormy cloud from the vicinity of San Pietro, in Cassale, rose about ten o'clock A.M. it directed its progress towards the Duchy of Galiero, destroying with hail the lands over which it passed; here, however, it encountered a "park" of paragreles, on an extent of about 10,000 acres. The hail ceased at this point, and snow alone fell:

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* Rapport sur l'utilitè des Paragrêles, &c. Paris 8vo. p. 1.

continuing its movement, the storm cloud finally encountered, in the Commune of Altedo, the district supplied by Dr. Astolfi; it seemed now to be considerably agitated, was observed to sink considerably, and finally to vanish away, after a fall of rain. We find also in an official notification to the Milan government, by the *Gonfaloniere* of *San Pietro, in Cassale,* (Signor Grandi,) that during a severe tempest of thunder and lightning, he went out to reconnoitre the effects of the paragreles; and observed the electric fluid playing round their summits in graceful curves *(courbes gracieuses,)* while in the adjoining fields the lightning did much mischief. Letters of a still later date, state that a line of storm clouds formed beyond the districts supplied by Messrs. Bruneti, Astolfi, &c. no sooner approached the paragreles than they sunk to a lower plane, lost the *peculiar colour*, which the peasants know from costly experience, is the feature of a severe storm, became white, precipitated snow, and finished in a shower of rain.

A report on the paragreles has been made to the Academy of Sciences, at Paris, favourable to them, and even a society of assurance against hail is already founded on a belief in their efficacy. By order of the Sardinian government, the Royal Society of Agriculture of Turin appointed a commission to inquire into all that had been said or done on paragreles: 1467 paragreles, it appears, were placed near Chambery, on a chain of mountains from their base to their summit. On the 5th of August, 1825, a violent storm took place, which extended exterior to the pale of the paragreles, but no hail fell among them; beyond their sphere, however, both hail and thunder were abundant. It appears also, that on the 11th November, 1825, a proprietor who had only four paragreles, each 22 feet high, saved his lands from a violent storm which fell on his neighbours.

Mons. Baron Crud, in a letter to Professor Chavannes, dated 19th July, 1824,* observes, that in the preceding month a storm cloud appeared, toward evening, to stretch itself over the paragrêles, and was attended with frequent lightnings, and altogether formed an undulated horizontal line: it finally rose into the higher regions, *none of it extended* toward the earth, and he observed that the lower regions of the air seemed to be deprived of their electricity: on another day, he continues to remark, a hail storm fell in the territory adjoining the paragreles, a sprinkling of small hail fell at the first line of paragreles, *but none whatever beyond that point*: on two several occasions, he adds, it was observed by the country people, that when the storm clouds approached the paragreles, they *parted in sunder and passed by on each side.* All these taken together form such a host of evidence as to be irresistible. When in Switzerland, in 1825, we every where received confirmations of their complete success, nor could we find a solitary proof of a single vineyard or corn field throughout, supplied with paragreles, at all injured by hail storms; but, on the contrary, a few miles from Neufchatel, where, from superstitious motives paragreles had not been erected, the vineyards were totally destroyed by hail, while those supplied with *them were wholly uninjured.* We must, therefore, reasonably infer that these extraordinary exemptions from destruction are the purchase of this practical application of scientific truth: the shielded districts were in the very tract of the storm cloud, nay, it passed over them harmlessly, or if it halted in its progress, or hovered over them, its depositions were of so soft and mild a character that they were powerless. We in this country, can form no conception of the dreadful devastations occasioned by hail storms on the continent. Incorporated societies are formed for the express object of insurance against hail storms, but we venture to predict that, on the paragrele being universally adopted, an epocha not very distant, such companies will be found unnecessary, and already an immense zone of paragreles protects the territories that skirt the line of the Po.

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* Feuille du Canton de Vaud, p. 277, &c.

We shall now proceed to detail some theoretical illustrations of the action of the paragreles on the storm cloud; but were we *unable* to accomplish this, the testimony of fact would certainly command our vote in their favour, and facts will maintain their commanding attitude irrespective of all theory: it seems clearly proved that *hail* is an electrical phenomenon, and it has also been decided that *lightning rods* have protected fields from the devastations of hail, while adjoining fields have suffered, and on this principle, a Mr. Williams, some years ago, proposed the erection of lightning rods in our own country; but we would much prefer an army of paragreles to lightning rods placed at great distances: the influence of the latter has been limited to a radius double the length of the conductor merely, whereas the multiplication of points, as in paragreles, and their short distance apart, supply every desideratum wanting in the other, not to mention the vast expense of lightning rods, which would completely preclude their adoption. If an insulated thunder rod can discharge the storm cloud of its forked and fiery elements, and scatter its parts to the four winds of heaven, *à fortiori*, paragreles, or pointed metallic wires, infinitely multiplied, and extending over a vast surface, must exercise a power infinitely greater. By means of rain or hail, the electricity of the cloud descends to the earth, and these are more violent in proportion to the electric power treasured up in the cloud, and the resistance opposed by the atmosphere: hail and rain are therefore the conduit pipes by which this discharge and descent are effected, but these are very imperfect conductors, and it follows that in presenting a superior conductor in the form of a point, the lightning will prefer a descent by such a channel, and thus the electricity which aggregated the cloud being withdrawn, it separates and dissolves; a series of points therefore draw off the accumulated electricity in silent capillary streams, attenuated to their ultimate degree, and it hence follows, that the watery mass, in its cloudy reservoir, will experience a similar and conformable attenuation, and then, of necessity, will follow its resolution into gentle rain, or its congealed counterpart, snow. It is a matter of surprise that extensive conducting surfaces are seldom, if indeed ever, injured by lightning, and we suspect, when they are struck, it will be found to be connected with some point more elevated than the rest: the copper roofs, so extensive in their range, in the great Dock-yards of Devonport and Portsmouth—arsenals and armouries, iron stores, cast-iron forges, &c.—iron bridges, and the like, are sufficient proof: the most extraordinary evidence of this kind I ever saw, was that of the gunpowder magazine at Chester, which was actually roofed and surrounded by a chevaux de frize of iron spikes, for its safety! we believe that this extraordinary arrangement has been since altered. These severally concur to prove that a multiplication of points, or extension of conducting surface, tends to attenuate and diffuse that electricity, which would otherwise in a dense and concentrated form, be mischievous in an imminent degree. Hence in large cities or towns accidents by lightning are rare, and when they do occur, are determined by some adventitious circumstances: in these cases, the aggregate of chimnies supplied with fires, or lined with carbonaceous matter, supplies the place of multiplied conductors: the destructive effects of this formidable meteor being reserved for the insulated mansion or the tree, or the solitary cottage. If an insulated rod be presented to a dense aggregate of accumulated electricity, it must enter in one united torrent; but if this were supplanted by numerous distinct rods at a certain distance apart, it is equally obvious, that by affording so many distinct channels for its escape, its intensity and force would be subdivided in the ratio of their number: in the former case it is an unbroken wave, and in the latter instance parted into many fractions: united strength in the one, and in the other it is enfeebled by division. Suppose a small pail with water were appended to the conductor of an electrical machine, having an orifice too fine for the water to drop from it, we should find, on electrifying this pail, that the water would be discharged in *minute streams through the orifice* in question : if we now present a point to the conductor at a certain distance, sufficient to withdraw only a part of the electricity, in this case, the discharge from the pail would be diminished in the same proportion, and the stream or streams will be still more minutely divided than before: let us suppose again that *several points* are presented to the conductor sufficient to effect at the former distance, a complete and entire discharge of the electrified surface; in this case, no water whatever will flow from the little vessel. A sponge saturated with moisture, attached to the conductor of an electrical machine, and thus operated upon, affords a very good elucidation of the storm cloud, as affected by the paragrele, and it explains, we think, in a very satisfactory manner, how that, though beyond the periphery which embraces the field of paragreles, the rain may be violent, and the descending drops of considerable magnitude, or, being congealed, form hailstones or fragments of ice; yet are modified into gentle rain or snow as soon as they come within the pale of the paragreles, and when immediately over the central *chevaux de frize*, where a fasciculus of multiplied points effects a complete discharge of the electricity of the storm cloud, and of course that of its aggregated contents determined by it. This theory of the paragreles we offer as one every way satisfactory to our own minds, and on this principle it was we contended for the utility of the paragreles from the moment we witnessed their application in Switzerland and Italy.

We shall now proceed to a very transient examination of some of the chief grounds of *theoretic opposition* to their utility, premising, however, that this is not, as a Frenchman would term it, "*une question des mots*," but one which must be determined by the voice of evidence, and the amount of facts; and there is not a *solitary failure* that can be produced against them. The antagonists to the paragrele have asked what effect can be expected from brass wires of only a line in thickness,* attached to poles thirty-five to forty feet long, while the strongest bar of iron, properly adjusted, only acts in a radius of fifty feet? Our objections to *iron*, and the grounds on which those objections are founded, have been already stated, and a bar of iron may be *thick enough*, and (independent of its innate inferiority as a conductor, rendered still more so by oxidation) be at the same time vastly inferior to a very slender rod of copper; moreover, the extent of the radius of influence has no relation to the *mass* of the conducting material, but its length, while its conductibility will be paramountly influential. Were there only *one* paragrele, it could not withstand the accumulated force of the storm, but there being *many*, its electric power is divided into many minute ramifications,—a fact which is proved in artificial electrical experiments. It is again contended that paragreles to be efficient and successful, should *prevent the accumulation* of electricity in the storm cloud: now this is not their character; they would, it is true, prevent the formation of any storm cloud *above them*, but these messengers of destruction come from afar: the cloud, long before its approach, has been already charged with electricity; the paragreles simply withdraw, as so many capillary channels, that electricity on which its destructive features as a storm cloud depend. Passing over many trifling objections which have not the slightest pretence to legitimate influence, we may advert simply to that founded on the *altitude* of the clouds, which has been stated to be from 3,000 to 10,000 feet; how, it has been triumphantly asked, can a paragrele act upon or affect a cloud at this elevation? These individuals continue to forget, in their blinded zeal, that the lightning of the cloud at this assumed elevation has often *singled out* a conducting medium from among other diversified objects, and by it been conveyed to the earth, and a human being, no lofty object surely, in the middle of a field has been selected by the destructive meteor for its victim. We have already adverted to instances wherein electric gleams have appeared at no great elevation on conducting points, and could add to their number by evidence collected both from ancient records and from every day occurrence: we have stated, that during thunder storms, the metallic points of the fire-arms in the armoury of the Tower of London have been noticed to glance with electric fire, and circumstances of a similar kind have been recorded. Pliny, Livy, Cæsar, and others, record curious facts of this description: the most interesting circumstance connected with these phenomena we find in the last mentioned author: In the month of February, toward the second watch of the night, a dense cloud suddenly approached, accompanied by a *terrible hail storm*, and in the same night the *tips of the lances of the fifth legion seemed on fire*: the passage being extremely interesting, as at once confirmatory of our position that the *hail storm is an electric phenomenon* and of the *efficacy of the paragreles* as to their receipt of the electricity of the cloud, (and paragreles, it will be admitted, are more *elevated* than were the spears of the fifth legion of Cæsar's army) we record it—" Per id tempus feré Cæsar exercitui res accidit incredibilis auditu, nempe vigiliarum signo confecto, circiter vigilia secunda noctis nimbus cum saxea grandine subito est cohors ingens; eadem nocte legionis quintæ cacumina sua sponte arserunt."* In the Abbè Bertholon's work on the electricity of meteors,† we find the following very curious and interesting practical phenomenon: it appears that there has been from time immemorial on one of the bastions of the Castle of Duino, situated in the Frioul, on the Adriatic Sea, an iron pike attached vertically to the wall during summer; when the weather inclines to be stormy, the soldier that mounts guard examines the iron of this pike in presenting to it the iron-shod summit of a halberd, which remains there for the express purpose; when he perceives that the near approach of the halberd causes the iron of the pike to sparkle much, or that there is on its summit a spark of fire, he sounds a bell near the spot, to give warning to those that are working in the fields, or the fishermen on the sea, that they are threatened with a storm, and on this warning all return home. This most singular custom, it appears, has been the practice of *centuries*, and how very easy would it be for us to establish such a faithful test of the approaching storm, where it might be especially beneficial, and save many lives, as for instance, on the nearest coast to any fishing ground, such as the Isle of Man, Highlands of Scotland, &c.?

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* A line may be considered as 1-12th of an inch.

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* Cæsaris Com. de Bello Afric. Cap. VI.

† A Lyon, 1787. 2 tomes.

We would now earnestly recommend the general adoption of paragreles in Great Britain; one has been already reared on my suggestion, and its phenomena, singular and interesting. Withering and blighting blasts, and the torrents of rain that fall so partially in Spring and Autumn, and oftentimes with such "fell swoop;" all these, and other meteorological phenomena, may be modified by conducting rods in the form of paragreles, and the result be of incalculable benefit. Whatever changes the electric character and state of the atmosphere, the grand depositories of the storm cloud, and all its icy and tempestuous contents, must necessarily operate in the amelioration and modification of climate; and paragreles, judiciously distributed, may be expected to do all this and much more than imagination can conceive, or the mind's eye circumscribe. Typhus fever, for instance, has its lines of demarcation, and pays its regular annual visit; and *bronchocele* again is obstinately and permanently attached to particular places: to ascertain whether any, or what effect the establishment of paragreles in such lines and localities, would produce, might be a question at any rate of curious interest, and we cannot tell *á priori* what might be the results: the phenomena are altogether involved in inextricable difficulty, and in our present state of knowledge none can venture an opinion, our data being quite insufficient. Corn fields, farm yards, orchards, and gardens should be supplied with paragrêles, and particularly gentlemen's lawns and parks. Paragrêles might be so disposed as to be at once ornamental and useful—the clematis, rosa multiflora, passiflora cærulea; or the hop, scarlet trumpet honeysuckle, &c. might be entwined around them; they are required where insulated trees are detached from the general group, such being particularly liable to be struck by lightning; but above all, in the case of extensive ranges of glass, as conservatories, stoves, greenhouses, &c. and we believe that, even in this country, the annual destruction of glass by hail-storms, may be fairly estimated at many thousands, independent of the injury done to the exotics. Gunpowder magazines should be surrounded by a double line of paragrêles: all would be safe and secure within the circumscription of the charmed circle. We know not what effect a circle of paragrêles would have on the fish-pond; it has been suggested to us by the Rev. Mr. ———, a scientific friend, that it might prevent its freezing; this is perhaps, however, rather doubtful, since the effect is one connected with radiation.

The hop, on which so much commercial speculation is hazarded, and from which crop so considerable a revenue accrues in the form of duty, is a most precarious source of emolument to the grower, who has many enemies to contend with in the insect world, as well as causes that are unsuspected by him: the roots of the plant are subject to the depredations of a singular species of moth, called the *ghost*, (*Hepialus humuli*, of Fabricius,) while a small beetle, the *Haltica concinna*, is particularly destructive, early in the season, to the tender shoots: but the grand question of the crop hinges on the presence or absence of *aphides*, termed "the fly:" which has indeed been pronounced "the barometer that indicates the rise and fall of the hop grower's wealth."* The presence of the aphis will entirely depend on some morbid change, (else we are much deceived in our observations,) in the plant itself, and these are linked together as cause and effect; now this morbid change will be connected with corresponding mutations in the atmosphere. Some blight imported on the wings of the wind, by which the ambient air is parched, while a crippled and deceased vegetation transpires from its leafage the saccharine exudation called "honey dew;" and as the eagles will collect where the carcase is, so aphides congregate where the leaves are imbued with this morbid nectar. It is true, various opinions have been entertained on this question, and not a few individuals maintain that this honey dew is a secretion of the insect: if a distinct electric change had not been in these cases the often decided precursor of their presence, we might have closed with the opinion, but as the fact stands we cannot give up convictions founded on the repeated evidence of our senses. Last summer, in particular, we investigated the phenomenon with great care—the weather had been parched and sultry, for some weeks previous, and the honey dew prevailed to such an extent that the leaves of the currant, raspberry, &c. in the gardens, literally distilled from their tips a clear limpid *honey dew*, excreted from the plant, for the phenomenon was observable on those plants that were *entirely free from aphides*, and so copious was it, where these insects were found, that had their numbers been *centuple* they could not certainly have been the source of supply—the question with me, however, was set at rest by applying a lens, having previously washed and dried the leaf by a sponge, for in this case the immediately excreted globules became apparent. Our opinion is at complete antipodes with that of Mr. Major,* who has so singularly confounded the "honey dew" with the gumo-resinous excretion of the *acacia glutinosa*, the horse chesnut, and the tacamahac tree, (populus balsamifera,) including even the family of the *cisti*, and of course the *cistus creticus*, which affords the well known gum resin called *gum labdanum*, being obtained, occasionally we believe, by combing the beards of the goats that browse on the shrub in the island of Candia.

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* Introduction to Entomology, Lond. 8vo. 4th Ed. 1822, Vol. I. page 182.

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* "Treatise on Insects," Lond. 1829, 8vo. p. 17, &c.

If it be probable, and we think the inference evident, that an altered electric state of the atmosphere precedes the appearance of the "fly" on the hop plant, and that this presence is the signal of disease consequent on a previous morbid change, there can be little doubt that erect copper wires attached here and there to the poles in hop plantations, thus forming so many paragrêles, might produce a beneficial effect, and act as a counterforte to those electric changes that operate so fatally on the *hop bine*. Is it not a matter of notoriety to the hop farmer, that, by a favourable change in the weather, the already threatened crop *suddenly* assumes a livelier and healthier livery, or, to use his own expression, "*recovers*;" while the aphides, on which all the blame is laid, without the lady bird (cochinella) having thinned their ranks, as *suddenly disappears*, as was their advent; when, to use the grower's phrase, the hop plant was in the first instance "struck" by them?—the truth is, their nutriment has vanished, and their withered and blanched exuviæ attest the circumstance.

To conclude,—such a formidable *chevaux de frize* of pointed electric conductors must be a far more effective shield of safety for our houses and lands than an insulated thunder rod, (which, as generally constructed, is mischievous in an eminent degree) besides being much less costly. The one in its best estate possesses only a partial agency, the other embraces a vast range, and is complete and efficient—the latter in its perfect form may shield the wing of a building, the former encompasses the entire domain of our persons and property, and scatters, as it were, the salubrious elements of an ameliorated and chastened clime over our vegetable tribes, as well as our flocks and herds, imparting the softening influence of a better than Italian and insular clime, checking by a mighty counterforte the abrupt transition of its continual vicissitudes, and arresting the inroads of disease.—So true is it that Omnipotent Wisdom, who "MAKETH LIGHTNINGS WITH RAIN," hath also in the conducting wire, "PREPARED A WAY FOR THE LIGHTNING OF THE THUNDER."

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